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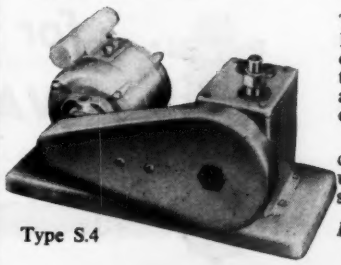

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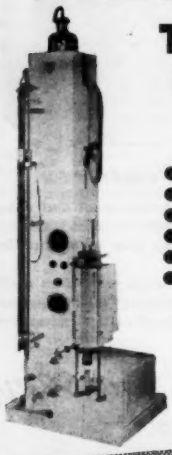

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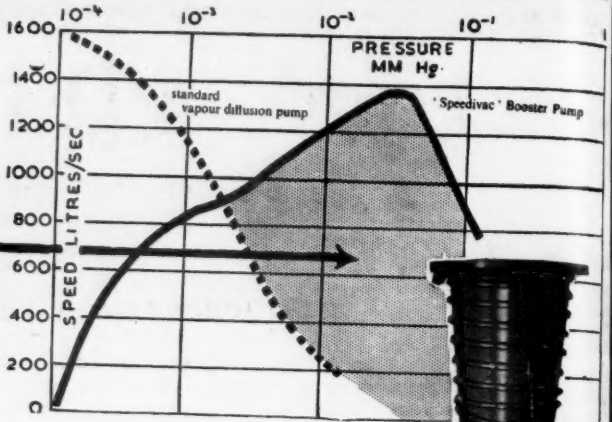

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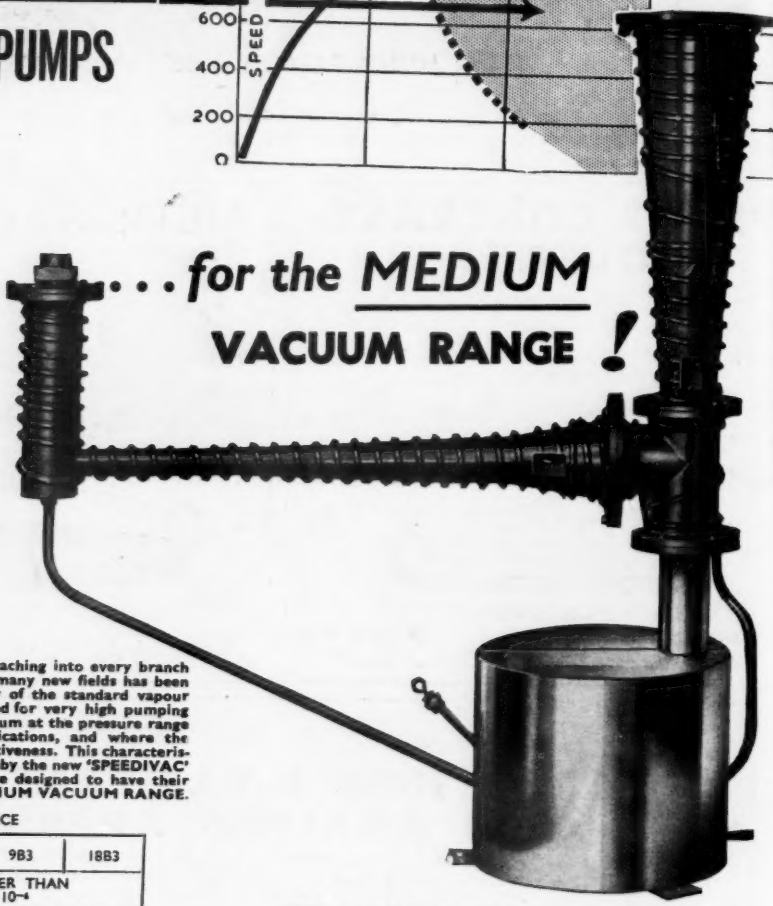

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SCIENCE IN INDUSTRY: MATERIAL AND HUMAN FACTORS

THE working conference on research and industrial productivity which was arranged by the Department of Scientific and Industrial Research in association with the British Productivity Council (see *Nature*, January 8, p. 66; 1955) was concerned essentially, as Lord Salisbury emphasized at the opening luncheon, with the scientific aspects of productivity. Its discussions in general did not deal directly with research in technology: they were concerned rather with the directions in which further research in such matters as alternative methods of working, work study and industrial operations and relations generally could contribute to the more effective utilization of existing knowledge, the reduction in the time required for the development of technical innovation and the improvement of industrial productivity in general. The conditions which determine the rate of technical innovation were critically and carefully examined, and numerous suggestions were made as to further scientific studies which might enable obstacles to be removed and so improve the standards of both management and operatives as to increase productivity.

The efficiency and progress of industry, as Lord Salisbury observed, is not solely a matter for industry itself. It is a matter with which any government must be concerned, and it may not be without value that the Conference should have drawn from Lord Salisbury this frank admission of government responsibility and of the contribution which the Government itself could make to industrial productivity, not simply by encouraging progressive industry but also by shaping national economic and financial policies so as to create a more favourable climate for higher productivity. Nor is this a matter of party politics. Neither major political party has yet given evidence that it is prepared to make the impartial approach that is required, or to undertake the essential educational work, above all when that runs counter to some particular political prejudice or party dogma.

Here indeed are to be found the two main threads that seem to run through the discussions and which are inextricably mixed. First are the recognition and demand for more quantitative study of industrial operations of all kinds and at all levels, from that of research to development, production, market research and distribution, and using all possible appropriate methods—operational research, measurement of productivity, work study and the rest. When such quantitative study has provided the factual basis for decisions, those decisions cannot be taken and put into practice without consideration of the human and psychological elements. The importance of these elements in making decisions, in providing a sense of participation and in removing the frustrations of industry was the second main thread in the discussions.

That aspect was emphasized from the start. Lord Salisbury said he does not believe it is possible to over-estimate the importance of the psychological approach; this might play an indispensable part in the future in counteracting that boredom and fatigue which are the inevitable result of the increasing mechanization of industry. Moreover, as Sir Ben Lockspeiser pointed out, while the fully automatic factory, for example, is on its way and we cannot choose whether or not to make changes which carry economic advantages in competitive markets, such changes demanded by technology are apt to conflict with habits of work and ideas of management. Some of the old conceptions still current on both sides of industry are quite out of keeping with modern technology, and much fresh thought is demanded—of governments as well as of employers' federations and trade unions—on human as well as technical problems, if an old traditionally minded democracy such as ours is to preserve its freedoms and earn its living in a competitive world.

Sir Ben described the changes connoted, for example, in the coming of the automatic factory as tantamount to a second industrial revolution; but what seems equally clear from the discussions at this Conference is the extent to which a revolution in thought is still required on both sides of industry and indeed among politicians. Even in the research programmes of the Department of Scientific and Industrial Research, Sir Ben noted, it is necessary to study more closely the needs of industry and the conditions under which it operates, to think in terms of costs and economics and human values, as well as of science, in order to achieve right emphasis and apply the results successfully. In confirmation of this, in speaking on economic factors in planning research, Dr. R. M. Lodge, research manager of British Nylon Spinners, stressed the necessity for much more careful attention in planning on the production and sales side a milieu receptive to research ideas, and also insisted on the importance of the human element; he referred particularly to the importance of planning consciously to provide the right atmosphere in which research can flourish and the dependence of research to-day on group- or team-effort.

Dr. Lodge also suggested that, with the present scarcity of scientific and technical man-power, it might be necessary to give much more thought and attention to the best possible means of using the available qualified men, even if it caused rearrangement of the traditional laboratory organization so as to relieve the limited number of more highly trained men, and those most capable of original thinking, of routine activities. The most effective use of our resources of scientific man-power to-day will scarcely be secured without pursuing this principle much more carefully and thoroughly, not only in industry but also elsewhere, including the university laboratories and research institutions, and the science teachers in the schools and technical colleges. The attempt to do so, moreover, will frequently encounter similar obstacles to those which hinder attempts to secure the adoption of technical innovations or more

efficient methods of working, namely, lack of human understanding and co-operation.

The critical factor is indeed everywhere the psychological one, and ultimately at whatever level the task of improving industrial productivity is approached, from the research department to the sales department, the real problem is one of communication, in the true sense of the word—of promoting a clear understanding on the part of all concerned of what requires to be done and why, of how it affects them and the contribution which they are called upon to make. While the discussions at the Conference stressed the need for more quantitative knowledge and the importance of taking full account of the human factor, they equally made manifest the extent to which the whole of the research programme of the Department of Scientific and Industrial Research and of the research associations has already been influenced by such ideas and is aimed in one way or another at increasing industrial productivity, interpreted in the broadest sense. Still more, however, did the Conference manifest the extent to which human neglect, prejudice or ignorance persist in preventing the nation from reaping the full benefit of existing knowledge and drawing the greatest possible advantage from its natural resources, even those that, like fuel, are dwindling seriously.

One of the most disturbing papers in this respect was that of Mr. K. T. Spencer, chief scientific adviser to the Ministry of Fuel and Power, on the availability of fuel and its efficient use. Mr. Spencer, recalling the past dependence of the industrial progress of Britain on cheap coal, said that it has yet to be proved whether nuclear energy can restore the age of abundant energy, and at best many years must pass before nuclear energy can replace coal as our main source of energy. Meanwhile, we have to face a continuing fuel shortage which within the next decade may well involve a gap between supply and demand of some 20 million tons of coal per annum. So far, the increasing requirements of industry, with the production of coal declining, have been met by increasing efficiency of utilization, by reducing exports and by increasing the use of oil. Mr. Spencer reminded the Conference that hitherto mechanization has given no spectacular increase in output of coal, and the quality has deteriorated and is likely to continue to do so. It would be unrealistic, therefore, to rely on coal production increasing sufficiently to meet our requirements, and it would be equally unwise to regard with complacency an increasing dependence on imported petroleum. The soundest policy for filling the gap, he said, is to increase the efficiency with which fuel is used.

It is here, in his revelation of the extreme variations in the efficiency with which coal is at present used by different industries and in one and the same industry, that Mr. Spencer is startling and even alarming. He quoted evidence of waste that has persisted virtually unchecked for eighty years since it was condemned by a Commission of Inquiry appointed in 1871; during that period, according to a survey made by the Ministry of Fuel and Power in 1953, the average efficiency of the shell-type boiler had increased by about 10 per cent. Indeed, figures quoted by Mr. Spencer show that in some industries, such as paper and board, bricks and fireclay and cotton, productivity per ton of coal decreased between 1935 and 1948, although on the whole productivity per ton of coal slightly increased. But in individual industries the yield per ton of coal can vary hundredfold: for grain-drying, for example, from 5·6 tons to 224 tons; for beer from 18·5 to 112 barrels; for biscuits from 1 to 20 tons; in laundry work from 0·4 to 5 tons; in bronze and brass founding from 1·7 tons to 20 tons for billets and ingots, and from 0·2 to 2·5 tons for castings; and in continuous kilns for building bricks from 4·8 to 44·7 tons. An investigation of some twenty breweries, for example, by the British Coal Utilization Research Association indicated simple methods the adoption of which would save about 200,000 tons of coal per annum; and, quite apart from this, Mr. Spencer was able to point to some equally startling savings which could be achieved by the substitution of the most efficient plant for the inefficient plant so often used.

The challenge to thought represented by Mr. Spencer's paper is unmistakable, but the very magnitude of the task before us underlines the importance of the task of education. Clearly, a large amount of the information required for a fuel economy advisory campaign already exists; and clearly also the importance of there being within each firm someone abreast of scientific advance and able to appreciate its bearing on the technical activities of the firm is again demonstrated. The major problems are those of the communication of existing knowledge in the most appropriate and effective way, and the means by which the psychological and human obstacles to its utilization are to be overcome.

Here is a challenge to fresh and constructive thought, and indeed to further investigation, as was elaborated in some detail in various papers at the Conference, notably in those by Mr. N. Fleming and Mr. R. M. Currie. Though due weight was given to the technical factors, there was no disposition to over-rate either such factors or the economic factors on which other speakers like Mr. A. H. Wilson, Dr. C. B. Frisby or Mr. D. A. Oliver, for example, laid stress in considering obsolescence, the design of equipment, the organization of work and the exploitation of mineral resources. Whatever fresh facts are required as basis for decisions in particular fields, the overall need is for clear unprejudiced thinking about the whole situation, taking into account the scientific and technical as well as the economic and psychological factors before determining policy and action.

This challenge to study and thought emerges again and again in the most diverse papers presented at the Conference. It is the keynote, for example, of Prof. C. F. Carter's analysis of the economic factors in technical innovation and the justification for the studies of the obstacles to such innovations in business which are at present being examined by the Science and Industry Committee of which he is chairman. Prof. S. Zuckerman's discussion of the utilization of raw materials, with its emphasis not only on efficiency

and the elimination of waste both in production and use, but also on the desirability of living on income in this respect rather than on capital, is no less challenging. Long-term appreciations of the supply position make bigger demands on forethought than the short-term views which he criticized, and thought as well as fresh investigation will be required if renewable resources like cellulose are to replace wasting assets such as coal and petroleum as raw material for synthetic processes. Prof. Zuckerman pointed out how far we are from significant supplies of synthetic foodstuffs: the mechanism of photosynthesis is not yet fully understood, let alone reproduced in the workshop. It would be of very doubtful value to base any efforts in that direction other than on the production of nutrients obtainable at low cost of energy and materials from renewable assets.

The possibility of conflict between short-term and long-term considerations was admitted by Prof. Zuckerman; and it should be obvious that, when all that is possible has been done to secure the economic elimination of waste in production and utilization and the efficient use and co-operation of labour, the selection of materials and processes contributing to the soundest economy and conservation of natural resources involves decisions which can scarcely be taken without government approval and support. If little was said specifically on this point at the Conference, apart from Lord Salisbury's rather oblique reference at the opening luncheon, the vital bearing of government policy on industrial productivity and the conservation of resources was repeatedly indicated. The large savings in coal per passenger or vehicle mile which Mr. Spencer gave as possible by substituting electric trains for steam trains, or diesel locomotives or diesel road coaches for steam locomotives and trains, are unlikely to be realized without a change in government policy towards the re-equipment of British railways, for example. If, moreover, British industry is, as has been suggested, less willing than formerly to take risks, government policy can be the determining factor as between supporting weakness and encouraging initiative and enterprise.

Even here, however, we are concerned with the human factor. In the re-equipment of the railways, for example, the provision of the capital resources may well prove a small problem compared with that of the human adjustments and the revolution in working practices that will be involved in the replacement of steam working and the efficient use of new equipment. The problem of education and communication of ideas, knowledge and purpose is fundamental at all levels. Here the Conference seemed to be somewhat disappointing. What is needed even more urgently than the investigations in the field of work study, which Mr. Currie suggested, is a more determined effort to promote the understanding and confidence between management and workers on which high productivity depends.

Admittedly, evidence that management is alert and competent to take full advantage of advances in technique can help to establish such confidence. So, too, could the knowledge that research, such as Mr. Currie suggested, is proceeding into improved methods of operating, from the health and safety points of view, the economic, the physiological and the psychological points of view. But if the results of those researches are to be fruitful, the attempt to encourage receptivity to new ideas and practices must be proceeding now, and restrictive practices and ideas attacked at all levels, alike among employers' associations and among the trade unions. The promotion of a climate of opinion favourable to technical innovation and industrial productivity should receive the first priority.

The Conference gave little lead as to how this task is to be undertaken, or as to the most appropriate methods by which it could be approached. Dr. C. B. Frisby indicated the need for further consideration of means of communication as well as for the co-operation of different specialists. Dr. A. King, in summing up, recognized the value of a combined approach, and he and Dr. F. C. Toy both emphasized the extent to which the Department of Scientific and Industrial Research, with its network of research associations, is now regarded by the Government as one of the major means for transmitting ideas to industry. The other main national agency is the British Productivity Council, with its regional organization and circuit system, which endeavours to bring management and workers together in every main industrial area, using modern methods of presentation. These bodies have already done much, and it is probable that more will be done, particularly by the research associations, as their knowledge of the human aspects of production and innovation increases. If, however, the full co-operation of the human element is to be secured in the application of science in industry, commerce and the public services, from the level of director to that of operative, this problem of communication and the most effective methods by which it is to be achieved are, as Mr. L. T. Wright insisted at the Conference, of supreme importance. It is the problem to which, above all, the Lord President of the Council should give his immediate attention in following up the Conference, and it could fittingly engage the attention of the Parliamentary and Scientific Committee as well as of the British Productivity Council and all those bodies which, whether represented or not at the Conference, are concerned with the development of industry and the economic future of Britain.

FORMATION AND COMPOSITION OF COAL

Coal

Its Formation and Composition. By Dr. Wilfrid Francis. Pp. viii+567. (London: Edward Arnold (Publishers), Ltd., 1954.) 84*s*. net.

MANY coal-producing countries are to-day faced with urgent problems concerning their supplies of fuel. Some of these problems relate to the more efficient use of the available supplies of coal; some are concerned with the rapidly diminishing reserves

of certain all-important types and the employment, where possible, in their stead of more abundant kinds.

The solution of these difficult and varied problems will need the integrated effort and experience of specialists in many fields. The role of the fuel technologist is to effect this integration and to translate it into practice in the light of his own specialized knowledge and experience. It is therefore a noteworthy occasion when a comprehensive treatise appears on the subject which is the foundation of all fuel technology relating to coal, namely, the formation and composition of the fuel itself.

In presenting his book it is the author's intention "to help serious students of fuel technology and coal chemistry in all stages of their work". This he will undoubtedly do, because as the knowledge and experience of the practising fuel technologist widen, he will seek more and more frequently to find the key to the solutions of many of his problems in the constitution of the coal itself.

All studies of the constitution of coal must of necessity include considerations of the original vegetable matter from which the coal was formed and of how the various constituents changed, under different conditions of climate and environment, during the transformation into coal. Roughly one-half of the book is devoted to these matters. The subject-matter is illustrated by numerous photomicrographs the reproduction of which is beyond reproach except in certain isolated cases where the originals had been published previously by their various authors in a form not suitable for further reproduction. Many students will feel, however, that they would have obtained more help from the illustrations if, in some cases, the various plant tissues mentioned in the text had been suitably indicated.

The remainder of the book deals largely with coals of the types found in Great Britain and with certain of the methods which have been used for obtaining some insight into the actual chemical structure of the coal substance. As the coal matured through the various stages from peat to anthracite, there were accompanying changes in both structure and physical properties. Although coals at all stages of maturity are mixtures of the products of transformation of many different types of vegetable entities, their properties in general can be fairly accurately assessed from a knowledge of their elementary composition. On this fact are based all systems of practical coal classification. Failure occurs only in unusual circumstances. It seems to the reviewer that little is to be gained, except possibly in the more strictly scientific investigations, by the adoption of the elaborate system proposed by the author, which is based on the composition of the individual components of the coals.

It is somewhat surprising to find no mention of the work of Millott, Cope and Berry in the discussion of Hilt's law. Their examination of the coal seams encountered in a deep boring at Pie Rough, North Staffordshire, during a war-time search for oil provided a striking illustration of the truth of the law.

Occasionally a statement appears for which there is little or no experimental support. For example (p. 313), ". . . nitrogen and sulphur can replace oxygen in many ring structures with little effect upon the properties of the coal". The problems of coal constitution would be greatly simplified if such a substitution could be made with certainty under conditions where the ring structure of coal was otherwise undisturbed.

These are minor criticisms. The author has presented to students of fuel technology a book which deserves the highest praise and which will rapidly occupy a place of importance in the literature of the subject.

L. Horton

FURAN, ITS HOMOLOGUES AND DERIVATIVES

The Furans

By A. P. Dunlop and F. N. Peters. (American Chemical Society Monograph Series.) Pp. xix + 867. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) £7 4*s*. net.

FURFURAL, accidentally discovered by Döbereiner in 1821 and christened "artificial oil of ants", has to-day become a major commercial chemical. Its rapid rise to industrial maturity during the past thirty years constitutes one of the greatest achievements of chemurgy—the science concerned with the utilization of agricultural waste materials in industrial processes. The pioneering work of LaForge on the utilization of corn-cobs, the brilliant researches of Miner and Brownlee on oat hulls and the classic investigations of Mains on the furfural–water system are prominent landmarks in this notable development.

A derivative of furan, furfural, by virtue of its chemical reactivity, has become the source of many other important furan derivatives. With the advent of cheap and plentiful furfural, its industrial applications multiplied apace, and interest in furan chemistry, both in academic and industrial laboratories, received considerable stimulus. So voluminous is the literature on the subject to-day that the compilation of a monograph on "The Furans" was a truly monumental effort. The authors, eminently qualified to undertake the task, are to be congratulated on being the first to attempt a complete treatment of this important and rapidly expanding field of chemical endeavour, and the work ranks as a most valuable contribution to chemical literature. To keep the monograph within reasonable proportions (as it is, it runs to more than eight hundred pages) some omissions were inevitable. Thus, anhydrides, for example maleic and phthalic anhydrides, and γ-lactones which might in one sense be regarded as furan derivatives, and compounds wherein the furan ring is fused to another cycle, are not included, and the hydrogenated furans are only discussed in relation to their commercial importance.

Starting with a general review of the chemistry and structure of the furan series of compounds, the authors proceed to a detailed discussion of the chemistry of furan, its homologues and derivatives with halogen, nitro, hydroxy, amino, keto, carboxyl, aldehyde and metallic groups. The chapters on furfural, its production, analytical methods, physical and chemical properties are extremely well written. This first part of the monograph concludes with a review of the hydrogenation and cleavage reactions of the furan nucleus. The second half is devoted to the industrial applications of furfural as a chemical intermediate, industrial solvent and for resin manufacture. Pride of place in the first role goes to the use of furfural for the synthesis of adiponitrile, key intermediate in the nylon synthesis. This use is now the largest single outlet for furfural. A propitious

combination of physical characteristics makes the aldehyde a valuable and selective solvent, and both furfural and furfuryl alcohol find extensive use in the manufacture of synthetic resins. These applications are fully covered and a compilation of patents relating to furan resins is appended.

The book has many excellent features and is very well produced. It is authoritative, and, within the limits defined, comprehensive. It is to be regretted that the high price, possibly justified in the light of present-day production costs and the labour involved in its preparation, will severely restrict the sale of this most valuable treatise. J. IDRIS JONES

SCIENCE AND TECHNOLOGY OF TEXTILE FIBRES

Matthews' Textile Fibers

Their Physical, Microscopic, and Chemical Properties. Prepared by a Staff of Specialists under the Editorship of Herbert R. Mauersberger. Sixth edition. Pp. x+1283. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) £6 12*s*. net.

IT is just fifty years since the first edition of Matthews's "Textile Fibers" appeared—a half-century that has witnessed the birth and rapid expansion of modern textile research, and the concurrent development of the technology of man-made fibres to its present size and importance. As was inevitable, during such a period, a steady stream of revisions has been necessary to keep such a fundamental reference work abreast of the times. The present edition, the sixth, worthily maintains the succession. As in the case of its immediate predecessor, it consists of a series of monographs, by distinguished American authors, which together cover the whole field of the textile fibres—natural, artificial and synthetic, their identification, properties, uses and assessment.

The weakest section is that devoted to fibre-testing methods, which remains practically unaltered from the previous edition. Whereas much of the early testing apparatus described has no modern interest and could have been omitted, no reference is made to the considerable volume of work that has been published on the bending properties of fibres, abrasion resistance, fatigue effects and creep phenomena. Of the ninety-five references contained in the bibliography of this section, only eight refer to work carried out within the past ten years. There is also a serious double transposition in the text on pp. 1245–1247, which should be corrected in any future impressions.

In compensation, the section devoted to the microscopical and physical properties of wool, revised to include recent electron-microscopic studies, is excellent, as is also that dealing with the interpretation of X-ray fibre photographs, written for the non-specialist reader. This latter section appears for the first time in this edition. The sections concerned with man-made fibres have been considerably revised and extended, and, so far as the inevitable delays of publication allow, they are up to date. The need for a revision of these sections was, in fact, one of the chief reasons for the present edition, and it has been admirably met.

The book is well indexed, and the bibliographies appended to each section greatly enhance its value as a work of reference. As "a textbook for use in colleges and technical schools" in Great Britain, its strongly American flavour, inevitable in view of the general authorship, is a decided disadvantage. Nevertheless, it will continue to be used for reference purposes, in the future as in the past, because of the scope and competence of its contribution to textile knowledge.

BIRATIONAL GEOMETRY

Methods of Algebraic Geometry

By Prof. W. V. D. Hodge and Dr. D. Pedoe. Vol. 3, Book 5: Birational Geometry. Pp. x+336. (Cambridge: At the University Press, 1954.) 40*s*. net.

THE scope of this book is more restricted than might have been expected from the title. It does not deal with birational geometry as a whole, for the fundamental properties discovered by the great Italian geometers have been entirely omitted. The reason for this is explained in the preface. The authors' intention is to explain methods, not results or a unified theory, and not all methods, but only those based upon the modern abstract algebra of rings, ideals and valuations. These methods are largely due to the recent work of O. Zariski. The reader is assumed to be already versed in the ordinary methods of algebraic geometry. On the other hand, no knowledge of abstract algebra is assumed, beyond that contained in the earlier volumes. It is a great convenience that the geometer will find in this volume and the earlier ones all the algebra he needs, though it entails that nearly half of this volume is algebra rather than geometry.

This volume contains four chapters. The first deals with the theory of ideals in a commutative ring, including prime and primary ideals, remainder-class rings, subrings, extension and quotient rings, modules, multiplicative theory of ideals, and integral dependence. The second chapter deals with the arithmetic theory of varieties and applies the results of the first chapter to geometry. Great stress is laid upon projectively normal varieties, which are used extensively in the more advanced parts of birational theory. The third chapter deals with the concept of abstract algebra known as the valuation of a function field. This generalizes the classical theory of a branch of an algebraic curve, and is of fundamental importance in the theory of birational transformations. The authors point out that many of the results could have been obtained more simply and elegantly by Weil's method, using what are called specializations. However, it is unlikely that a complete theory of birational transformations can be built up without valuations, so geometers should study this method. Valuation theory can also be applied to the theory of numbers, but the account here is restricted to what is required for geometry.

The fourth and last chapter is entitled "Birational Transformations". Most of it is devoted to problems concerning multiple points. A problem still unsolved is whether we can obtain, for every algebraic variety, a birational transform without multiple points. Some light is thrown upon the structure of multiple points by Zariski's local uniformization theorem. No less than seventy pages are devoted to the proof and applications of this fundamental theorem. The volume concludes with two pages of bibliography and bibliographical notes, and an index.

H. T. H. PIAGGIO

SCIENCE AND ADULT EDUCATION

THE ROLE OF THE UNIVERSITY EXTRAMURAL DEPARTMENT

By Dr. H. D. TURNER
University of Sheffield

IT is extremely difficult to define clearly the aims and purposes of adult education. This is due partly to the number of different activities and subjects which it embraces; partly to the various ends which it is designed to serve; and partly to the number of organizations concerned in its provision. A precise definition of science in adult education is impossible for similar reasons.

The general case for the inclusion of science as a humane study in adult education has been well stated by Peers[1] in his report to the Universities Council for Adult Education. There are, however, other equally important aspects of science and technology with which extramural departments may be usefully concerned, and it is at least arguable that teaching in these fields is one of their proper functions.

The following list includes most of the activities which, collectively, may be regarded as constituting science in adult education:

(1) The teaching of separate subjects such as biology, chemistry, physics and geology. These may be presented at various levels ranging from the most elementary introductory lectures to descriptions of recent advances.

(2) Courses, at various levels of presentation, in all branches of technology.

(3) Lecture series in the history of science and technology.

(4) Discussion of the impact of science and technology on society.

(5) Groups of special lectures in science and technology which may, for example, supplement normal courses in history and economics.

At the moment there is a general tendency, reinforced by the conclusions of Peers, to suppose that at the advanced level (1) is too difficult and at the elementary level is outside the scope of extramural departments; that (2) is not the concern of extramural departments; that (3) is unpopular and hence not worth attention; that (4) is not science and therefore not suitable for inclusion in science teaching; and that (5) is better done by the appropriate specialist.

We may say at once that (1) and (2) should, at the elementary level, be provided by local education authorities; and that, in the main, the problems raised by the impact of science and technology on society should be of interest to the Workers' Educational Association, since these problems are similar in origin and effect to those which stimulated the early development of the Association.

Many successful courses of the type included under (1) above have been given at Sheffield during the past six years. The Extramural Department has usually arranged and administered the courses, while the lecturing has been done by internal members of the University staff. The form of such courses must always be adapted to the requirements of potential students. For example, lectures and demonstrations on recent advances in various sciences are probably best given as one-day Saturday courses, since this is often a free day for graduates in teaching and in industry; but such provision should be supplemented, where possible, by longer residential courses. These, although more difficult to organize than evening lectures, offer great advantages; demonstrations and practical work are more easily provided; and the opportunities afforded for discussion and general social activities enormously enhance the value of the course. It is not difficult to believe that such residential courses may well become one of the most important features of adult education in the future. Sometimes, however, it may be necessary to stimulate interest in a subject, and form a class, by a series of progressive courses as, for example, in recent developments in the teaching of geology. A single public lecture had shown that a certain amount of interest existed in a particular area. This lecture, therefore, was followed by a short course on local geology which was so successful that it led to a longer course (of twenty meetings) on "The Scenery and Resources of Britain". From this has developed an intensive study course, attended by twenty-five students, which covers much the same ground as the first-year course in geology at the University; and this sequence is being increasingly used for the development of courses in other subjects. Courses of this type are generally restricted to the University and to large centres of population. In these the Department frequently organizes courses in co-operation with the local technical colleges, where adequate lecture rooms and reasonable facilities for practical work and demonstrations are normally available. Thus these educational needs of adults in the areas are provided by the resources of the technical college supplemented where necessary by those of the University.

Most universities have technological departments which often serve both local and national industry. There have been many interesting developments in these departments, such as the establishment of post-graduate schools of study, which are organized without the help of extramural departments. At the same time, the extramural department, with its contacts in industrial and educational circles, may often be able to advise in the provision and help with the organization of many worth-while courses, the need for which is not always immediately obvious. For example, at Sheffield the Extramural Department, in co-operation with the Departments of Metallurgy and Fuel Technology, has started a series of very successful advanced residential courses in "Fuel and Metallurgical Problems of Jet Engines" for engineer officers in the Royal Air Force; and there are obviously many similar fields in which the Extramural Department can pioneer new developments of mutual benefit to the Services, the university and industry.

Courses in the history of science and the history of technology are, unfortunately, rarely included in any educational scheme. There are many reasons why the universities should sponsor the teaching of these subjects. Their staffs include the necessary specialists with the requisite facilities. The history of science

and technology covers ground that is common to the arts and science; and the problems of liberalizing science courses and of interesting arts students in science may be solved by courses in these subjects.

Experience in the field of extramural studies shows that there is considerable interest in such topics and in the philosophy of science. A number of experimental courses in the history of science have been given, and in these the 'case-book' method developed by J. B. Conant at Harvard University[2] has been used and considerably extended. In the most successful courses various important experiments in the history of science, such as the analysis of light, the discovery of oxygen and the discovery of the electron, have been described and demonstrated, and their scientific and technological consequences discussed. One surprising feature of these lectures has been the large attendance of senior sixth-form grammar school pupils.

It has already been suggested that courses on the impact of science on society might very well be suitable for the Workers' Educational Association. Such courses have been given at the request of local Association branches; but generally the response has been very poor. Very much more could and should be done in this field; a technological society is obviously extremely unstable if its members are ignorant of and uninterested in technological developments and the problems which these pose.

There are certain parts of courses in history and economics in which contributions from scientific specialists are essential. Only a scientist can adequately assess the influence of scientific discoveries on the climate of scientific opinion and on technological development. Such experience as we have had indicates that, provided problems of continuity can be solved, joint extramural courses by, for example, a historian and a scientist are very successful.

Certain general conclusions may be drawn from what has been said above. For example, it seems desirable that extramural staffs (at any rate in science) should be primarily advisers and organizers, although they should obviously keep in touch with their subjects by research and by internal and external teaching. This means, of course, that the bulk of extramural science teaching will be done by internal members of university staffs. The university, however, has obligations to the community in which it is situated, and to the tax-payer who nowadays largely finances it. The discharge of such obligations may very well involve, among other things, the explanation of the nature, purpose and results of the research work which is being done by universities.

Although extramural departments should be prepared to co-operate with all who seek their help, their main concern should always be with the provision of courses, delivered at a university level, for those who are capable of benefiting from them. In practice, these will probably be ex-grammar school people whose spare time is often limited. Hence, much of this provision must be in the form of short intensive one-day, week-end or residential courses and series of, say, not more than six evening lectures.

The activities of extramural departments should be widely known and this means that extensive advertising of courses is necessary. This has the additional advantage that students recruited to an advertised course form a reasonably homogeneous group.

The extramural department should, at this time, be encouraged to investigate every possible field of activity open to it. Experimental work and courses of all kinds should be tried; and this means that its activities should not be artificially restricted by financial straitjackets or by out-worn regulations. For example, sixth-form grammar school students are not officially admitted to extramural lectures and classes. Yet they are adult; they are capable of absorbing information at the appropriate level; they are prepared to turn up voluntarily in large numbers for lectures on the history of science and on modern scientific and technological developments; and they are the extramural students of to-morrow. If they are encouraged to-day to look to the university, through its extramural department, for their further cultural education, the problem of recruitment to classes in the future may very well solve itself.

There can be no doubt that in order to achieve all this it will be necessary for extramural departments to be directed solely by the university council and senate working through appropriate committees. This would give the departments the necessary status and flexibility of approach; and the obvious corollary to this is that the money required to finance their activities should be provided by the University Grants Committee as for other university departments.

[1] Peers, Robert, "Science in the Extramural Work of the Universities" (Universities Council for Adult Education). See *Nature*, **174**, 166 (1954).

[2] Conant, J. B., "Harvard Case Histories in Experimental Science" (Harvard University Press, 1950).

RADIATION HAZARDS IN INDUSTRY

THE third conference of the British Occupational Hygiene Society was held on November 1 in the lecture theatre of the London School of Hygiene and Tropical Medicine, the subject of the conference being a consideration of the radiation hazards in industry. The chair was taken by Prof. E. J. King (Postgraduate Medical School of London). The subject was originally introduced at the second conference of the Society held in April 1954 when Dr. W. G. Marley (Atomic Energy Research Establishment, Harwell) delivered a paper on the permissible levels of exposure to ionizing radiations and radioactive materials. In this paper Dr. Marley discussed the basic 'tolerance' level or maximum permissible level for X-rays or gamma-rays, and then proceeded from the basic 'tolerance' for X-rays and gamma-rays to calculate the permissible exposure to various types of radiation, allowing for their relative biological effectiveness. Similarly, the maximum permissible body-burden of radium is a valuable starting-point for the calculation of maximum permissible levels of different radioactive isotopes taken into the body. Dr. Marley described the method by which international agreement on maximum permissible levels has been reached. The experience of the atomic energy departments and of radiobiological specialists in the United States, Canada and the United Kingdom has been compared in a series of tripartite conferences commencing in 1949. Since then, data have been considered by the International Commission on Radiological Protection during the meetings of the International Congress of Radiology in 1950 and

1953. The third conference of the British Occupational Hygiene Society therefore started with a knowledge of the maximum permissible levels and with the assurance that they are internationally agreed levels.

Dr. A. S. McLean (principal medical officer of the Industrial Group, United Kingdom Atomic Energy Authority) opened the third conference of the Society with a paper on the health of workers exposed to ionizing radiation. He referred to the history of man's use of atomic energy since the turn of the century up to the present time, when he has learned to exploit it on a grand scale. Dr. McLean was less concerned with the effects of massive doses of radiation than with the pattern of injury which may be the outcome of long-continued exposure just above the critical level for these effects. The consequences of chronic over-exposure have been seen in several groups of human beings, including painters of luminous dials, miners of radioactive ores, and pioneer workers in the scientific and medical fields; in addition, there has been a vast amount of experimental work with animals. From these observations it is known that the sensitivity of any organ of the body to the effects of irradiation is generally a function of the rate of cellular activity in that organ, so that the blood-forming and reproductive tissues, for example, are more easily damaged than the nerve tissue of the brain. Nevertheless, a tissue of relatively low sensitivity may be damaged exclusively when it is the site of selective localization of a radioactive substance which has entered the body. Thus, radiation protection contains two distinct problems which are concerned with the irradiation of whole or part of the body from the outside and with the irradiation of selected organs of the body following uptake of a radioactive substance by breathing or by swallowing. Dr. McLean discussed both these problems and listed the main body organs involved. Of particular interest to the medical officer is the detection of radioactivity in the excreta; but since in some cases this involves the determination of micro-micro-gram quantities of radioisotopes, the radiochemistry involved is not easy. Dr. McLean concluded with a review of the comprehensive medical facilities which are used in the selection of workers and in the maintenance of health in the workers employed in the atomic energy industry.

The second paper, dealing with radiation safety in the Industrial Group of the United Kingdom Atomic Energy Authority, was by Mr. D. R. R. Fair (head of the Health Physics Department, Windscale Works, Sellafield, Cumberland). He reminded the audience that, in thinking of radiation safety in industry, they must not think of scientists working in laboratories but of factory managers employing process workers and skilled craftsmen working in factories. He discussed external irradiation and the design office's contribution to the safety of the worker in the provision of radiation shields and the layout of plant and equipment to make use of distance for safety.

The contribution by works management to safety is called for when plant has to be maintained or modified. A decision has to be made whether to postpone operations in order to allow short-lived fission products to suffer radioactive decay or whether the radiation field may be reduced by decontamination of the plant. Before work commences, management has to decide whether local radiation shielding must be built, the workers have to be briefed on the method and sequence of work they are to carry out, and the time the worker is in the radiation field has to be carefully controlled. Mr. Fair then turned to the harder task of the atomic energy industry, the protection of the worker from the inhalation or ingestion of radioactive materials. The design offices have provided all-welded plant using a specially corrosion-resistant stainless steel, liquid transfer mechanisms by hypodermic needle, and adequate ventilation of working space with controlled direction of airflow and proper facilities for the workers to maintain the highest levels of personal hygiene. The management exercises safely control during maintenance work by reducing air contamination to a minimum, controlling both the volume of air which is contaminated and its disposal, and by providing the worker with clean air and full head and body cover while he is on the job. Mr. Fair discussed in some detail the methods by which management achieves these aims. He concluded by reviewing the position and responsibilities of the health physicist in an atomic energy works.

Mr. W. Binks (Radiological Protection Service of the Ministry of Health and the Medical Research Council) presented the third paper, and dealt with protection against X-rays and gamma-rays in the industrial field. He was particularly concerned with radiation hazards in ordinary industries. Experimental data were given on the direct radiation outputs from X-ray tubes and from radioactive isotopes, on the degree of scattering produced under different conditions and on the absorption of both direct and scattered radiation in materials such as lead, brick, concrete and soil. Mr. Binks discussed in detail the solution of a number of problems encountered in designing an industrial radiological establishment. Since the safety of personnel working with ionizing radiations depends as much upon adherence to particular techniques as upon the provision of structural shielding, Mr. Binks included details of the various monitoring techniques which may be adopted to assess the actual dose received by workers. Finally, he described the help which it is anticipated the Radiological Protection Service will give to industrial managements in designing radiological establishments and in carrying out radiation surveys and personnel monitoring tests.

The final paper at the conference was by Mr. F. R. Farmer, assistant director, production, of the Industrial Group, United Kingdom Atomic Energy Authority, Risley, who dealt with the safety criterion in atomic energy. Mr. Farmer made a review of the hazard-level in industry as measured by the death-rate and compared this in the working population age-group with the death-rate due to natural causes and to violence. He quoted death-rates of 10–12 for normal industry, 30 due to violence (including 12 on the roads), 80 for the mines and 140 due to natural causes, all per 100,000. In a civilization with a rising standard of living, changes in the public attitude to such figures may be expected and a demand will arise for preventive action to be taken.

Mr. Farmer posed the problem of the new industry and asked what should its objective be. While it may be argued that a zero risk is highly desirable, this, in the absolute sense, is not obtainable. It seems reasonable to set as a target for a new industry that it must be comparable with the best in other industries. Looking back over other industries, it is probable that safety has been influenced by the need of the industry to sell its products economically in a competitive market, and the cost factor in safety

must not be lost sight of if the atomic energy industry is to make its mark in the national economy. Mr. Farmer concluded that the safety aim of the atomic energy industry must be for perfection within an economic framework that will encourage the development of the industry.

Each paper presented to the conference was followed by a period of full discussion in which many points of principle and some of detail were discussed. It was agreed that the safety-level established in the atomic energy field compares very favourably with much of established industry, but that a larger experience of radioactive work in industry will be needed before final conclusions can be drawn.

D. R. R. Fair

RESEARCH ASSOCIATION OF BRITISH RUBBER MANUFACTURERS

OPENING OF NEW LABORATORIES NEAR SHREWSBURY

On November 23 H.R.H. the Duke of Edinburgh officially opened the new laboratories and headquarters at Shawbury, near Shrewsbury, of the Research Association of British Rubber Manufacturers. Some three hundred persons were present, drawn from all sections of the rubber and allied industries, together with representatives of government departments and other organizations connected with the rubber industry, and after the opening they were able to visit the premises and inspect the displays showing various aspects of the Association's work. In his speech to the company the Duke referred to the obligations of industry towards co-operative research and its results, and put in a strong plea for yet more generous financial support by industry of the Association's work. He also stressed very much the problem of getting a research association's results applied in industry—"probably the most complicated and elusive problem confronting the industry to-day".

The ceremony formed a fitting and stimulating climax to the efforts that have been made during the past years to provide the Association with premises adequate for its growing needs. Founded in 1919, the Research Association of British Rubber and Tyre Manufacturers (as it was first called) began work in two rooms in University College, London, and then in 1922 premises were acquired in Lansdowne Road, Croydon. For many years these met the Association's needs; but the very success of its work, and especially the demands made on it during the Second World War, led to an expansion that seriously overtaxed the available space. By 1948 it became clear that the only solution was to find entirely new premises, and bearing in mind that the 'centre of gravity' of the rubber industry lies in the Midlands rather than the London area, the Council of the Association decided, after exhaustive inquiries and searches, to acquire premises already existing at Shawbury. These were purchased in January 1952, and since then the task of adapting them has proceeded steadily. Now that task is complete and the premises have been officially opened, the industry possesses a research station of excellent design, attractive in external appearance and interior finish, and fully equipped for the important work that lies before it.

The new premises (Fig. 1) are near the village of Shawbury, 6½ miles north-east of Shrewsbury on the Market Drayton Road (*A* 53). Erected in 1938 by Shropshire County Council, they have a floor area of some 15,000 sq. ft. and stand on a level site of about 6½ acres. The whole building is on one floor, except for two flats over the front portion. Although built for a different purpose, the lay-out has proved surprisingly convenient for the laboratories, library, workshops and offices of the Research Association.

The laboratories proper are grouped into three categories: chemistry, physics and technology. The chemical laboratories are in two groups. In the first, the main laboratory is for analytical work, including the testing of raw materials, analysis of vulcanized rubbers, identification and estimation of synthetics, and so on, and has for this purpose many pieces of specialized apparatus. The equipment includes also a micro-balance, used in developing micro-chemical techniques applicable to rubbers and other polymers, a Spekker absorptiometer for colorimetric analyses, and an infra-red spectrometer which has been devoted particularly to the identification of organic accelerators and antioxidants in vulcanized rubbers. Other laboratories are fitted up for studies on adsorption of simple hydrocarbons on carbon black and other powders, as part of the research on the mechanism of filler reinforcement. The second group includes the main chemical research laboratory, at present devoted largely to studies on copper (and other heavy-metal) catalysis of oxidation and the development of improved sequestering agents for combating the effect of copper in promoting oxidative deterioration (ageing) of rubber.

The physics laboratories comprise two large adjacent rooms, one of which is devoted mainly to electrical measurements and has a full range of equipment for studies of volume and surface resist-

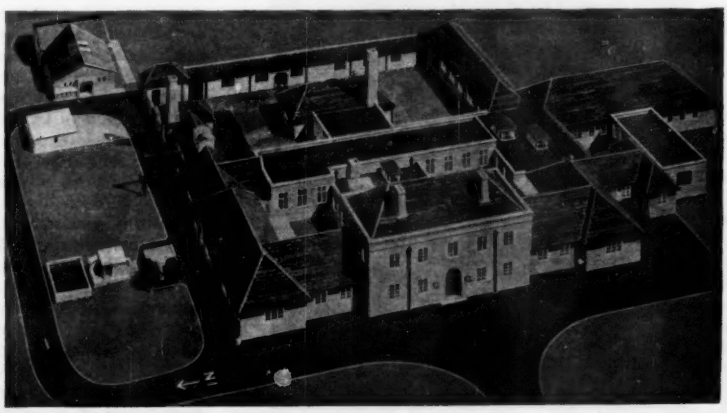


Fig. 1. Aerial view of new Laboratories of the Research Association of British Rubber Manufacturers

ivity, permittivity and power factor, as well as special apparatus for testing the electrical characteristics of 'anti-static' rubber, a subject to which the Association has made important contributions. High-voltage equipment is housed in the adjoining laboratory, which also deals with studies on plasticity, using in particular the Association's 'shearing-cone plastimeter' and various other types (Fig. 2). In this room also is installed the new sinusoidal-strain dynamic testing machine constructed to designs worked out by the Association, and which will enable more complete studies of the dynamic behaviour of vulcanized rubber to be undertaken than have hitherto been possible.

The technological laboratories include the mill room, equipped with up-to-date experimental mixing plant (both open-roll and internal types) and vulcanizing equipment (platen presses and open-steam pan); and the mechanical testing laboratory, which possesses a full range of instruments for examining the physical characteristics of vulcanized rubbers—strength, extensibility, 'set' or residual deformation, hardness, resilience, resistance to tearing and to abrasion, behaviour at low temperatures, etc. (Fig. 3). These instruments, particularly those for testing hardness, include several designed by the Association or by member firms on the basis of studies by the Association. Auxiliary laboratories contain equipment for testing the resistance of rubber to repeated flexing and to the deteriorating actions of heat, oxidation, light and atmospheric ozone. This technological equipment enables the research staff to prepare experimental rubber samples under carefully controlled conditions and to assess their properties and likely behaviour during use.

In addition to these various laboratories, the premises include the library and information section, or Intelligence Division, as it is called. This contains what is believed to be the world's largest library on rubber and cognate subjects such as rubber-like plastics, together with card indexes, now totalling some 750,000 cards, on which scientific, technical and commercial information on rubber is arranged in classified order for easy reference in answering inquiries and preparing literature surveys. Offices for typing and duplicating work, a photographic dark-room, an engineering workshop, and a spacious canteen complete the layout of a research station of which the rubber industry may well feel proud.

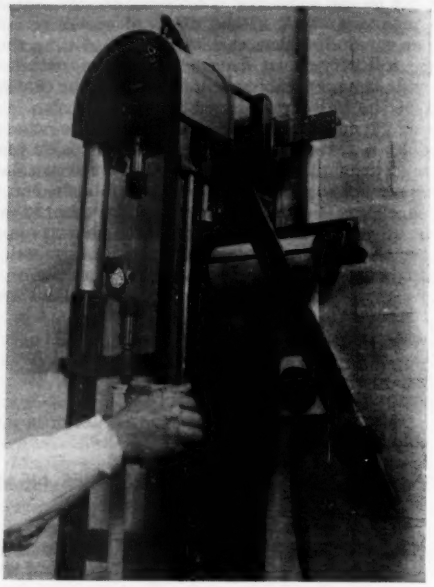


Fig. 3. Hounsfield tensile test machine, a recent British development

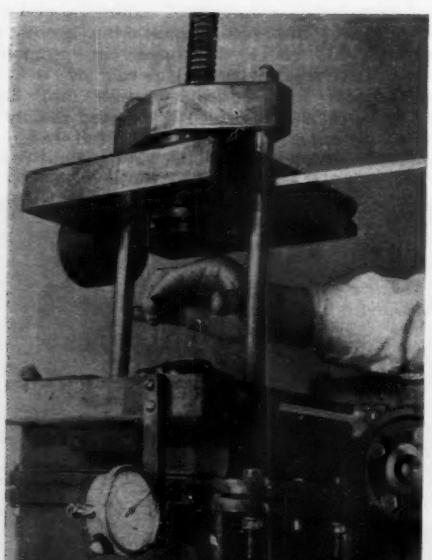


Fig. 2. Shearing-cone plastimeter for rubber

TREATMENT AND DISPOSAL OF SEWAGE SLUDGE

SINCE methods of treating water-borne sewage were first adopted in Britain, it has seemed obvious to many people that it should be possible to utilize profitably the plant nutrients which the liquid contains. That it is at least difficult to do this, and at the same time to dispose of the material without causing a nuisance or endangering public health, became clear during the second half of the past century when most of the sewage in inland districts was disposed of by irrigation on 'sewage farms'. For various reasons this method fell into disrepute—large areas of land were needed; land is usually expensive near towns, where most of the sewage is produced; the soil must be porous to permit irrigation at a reasonable rate; the sewage is produced continuously, but the farmer prefers to take it for irrigation only intermittently. Most sewage farms have now been replaced by modern, compact treatment plants which, at a remarkably low cost, are capable of converting sewage—often containing a large proportion of industrial wastes—into effluents which can be discharged to the small streams of Britain without serious risk to public health. The possibility of maintaining this position, but at the same time recovering further useful materials from

sewage, is, however, still often raised. Suggestions include using sewage effluent for irrigation, sometimes by distribution from overhead sprinklers, passing it through fish ponds, and using it as a nutrient medium for growing algae which would be harvested and dried. It was because of this widespread interest in the use of urban wastes that the Natural Resources (Technical) Committee, under the chairmanship of Prof. S. Zuckerman, decided recently to publish the results of its study of the subject*.

In the processes of treatment ordinarily used at a sewage works, as much insoluble material as possible is first separated by sedimentation, yielding a primary sludge containing perhaps 90–97 per cent of water. The remaining liquid is then treated by a biological process to give an effluent, which is usually discharged to a stream, and a secondary sludge of high water content. For every thousand persons there will be perhaps ten to twenty million gallons of effluent a year, with sludge containing twenty-five tons of dry solids.

Of the inorganic nutrients present in the raw sewage, a large proportion, including most of the potash and about three-quarters of the nitrogen, is discharged with the effluent; from a thousand persons the weight of nitrogen lost annually is of the order of two tons. The Natural Resources Committee recommends that methods of sewage treatment which would conserve the nutrients now lost in effluent should be investigated; so far as is known, no generally applicable methods are at present available, except that in arid countries sewage effluent is valuable for irrigation, much of its value being represented by its water content.

It is much easier, however, to make use of the sludge separated at a sewage works, and indeed it is estimated that the equivalent of some 350,000 tons dry material (containing some 8,000–9,000 tons nitrogen (N), 4,000–5,000 tons phosphate (P_2O_5), and 1,000 tons potassium (K_2O)) is at present applied to the land annually in Britain as manure. This is rather more than a third of the total which could be made available from the present sewered population of about 39 million persons; of the other two-thirds, part goes to sea, either in suspension where untreated sewage is discharged (as in Liverpool) or in tank steamers after separation on shore (as in London), and part is ultimately stored in tips at sewage works.

The chief difficulty in disposing of sewage sludge, whether for agricultural or other uses, lies in drying it to a moisture content at which it can be transported economically and handled easily. Several methods of drying are used, and it was known that the efficiency and cost of the process differed widely at different sewage works. A committee was therefore set up by the Ministry of Housing and Local Government to study the question, and it has now issued a most interesting report†, from which the following brief notes are taken.

The weight of sludge produced per thousand persons annually may range from ten tons in a rural district to more than eighty tons in an industrial one—clearly the composition of the sludge will vary equally widely. The price at which partially dried sludge can be sold (per ton dry weight at the works) ranges from nothing (air-dried to 65 per cent moisture) to more than £6 (digested, 15 per cent moisture, powdered and bagged). Digestion—that is, anaerobic fermentation to yield methane and carbon dioxide—is already in use at many large sewage works; the Committee recommends the extension of the process to smaller works. Of the more mechanical drying processes, filter pressing, vacuum filtration and filtration after heating are practised at a few works; but centrifuging, though used in the United States, has not been tried in Britain. A serious drawback of some of these methods is that the liquid which separates may contain a high concentration of organic matter and may add appreciably to the load on the biological stage of the sewage treatment plant. An interesting and effective method of drying consists in adding a coagulant, freezing and thawing the sludge, and then filtering; large-scale plant, however, has not yet been developed, and the economics of the process are uncertain. Electro-osmosis, already in use for drying soils in engineering work, appears to be inherently too expensive to use with sewage sludge.

After reviewing these various methods, the committee finds in favour of the simple and unmechanical, its choice of methods being in the following order: disposal in a liquid form, preferably after digestion, to manure agricultural land; digestion, and drying to 40–50 per cent moisture on beds or in lagoons; drying to 10 per cent moisture content after careful consideration of the possibilities of marketing the product; and finally—chiefly in rural areas—composting with other waste materials such as separated household refuse.

This report is valuable in giving an up-to-date and balanced account of the practice of sludge treatment in Britain; it will lend little support to the theory, so often put forward, that there is in sewage sludge a large unused source of nutrient materials which could be made available to agriculture without much difficulty if only the problem were energetically attacked.

* The Use of Towns' Wastes in Agriculture. Pp. iv+25. (London: H.M.S.O., 1954.) 1*s*. 3*d*.

† Ministry of Housing and Local Government. Report of an Informal Working Party on the Treatment and Disposal of Sewage Sludge. Pp. iii+64. (London: H.M.S.O., 1954.) 2*s*. 6*d*. net.

OBITUARIES

Prof. H. Terrey

THROUGH the death on Christmas morning of Prof. Henry Terrey, a loss has been sustained which will be felt in many departments of the academic life of the University of London, and in every phase of the life of University College. Prof. Terrey had been continuously associated with the University and with the College since 1912, successively as student, assistant, lecturer, reader and professor; and after his retirement from his University chair in September 1954 he had continued to serve the College by maintaining without interruption the discharge until the day of his death of the duties which had been his as a professor.

Terrey was one of that somewhat rare species at the present time, the true-hearted inorganic chemist, though with a well-assimilated knowledge of the principles, practice, and the helpful applications of physical chemistry and a general working knowledge of organic chemistry. For many years he had been the leader and mainstay of inorganic chemistry in a comprehensive chemical department in which the balance of interest between the branches has not always been easy to maintain. But Terrey was of the view that the best answer to that problem was

to have no incommutable branches and no boundaries; and the breadth of his general chemical knowledge, widely outside the orbit of his personal researches in the chemistry of the rarer elements and some other special fields, as was often shown by his regular and active participation in all discussions of researches in progress, fitted him well to put such policy into practice. His specialized knowledge of the factual basis of general and inorganic chemistry was unsurpassed.

It is impossible to overstate the value of his personal qualities to the University of London and to his College. Well adjusted, friendly and wise, he was the man to whom, even when he was still a lecturer, students and professors alike turned to naturally to talk over their difficulties, knowing that they would probably come away with practical help of one kind or another, and certainly with an easier mind and a clearer course of action. He was much interested and gave much help in the organization of students' athletic activities. His personal knowledge of students throughout the years was remarkable, and for a long period he gladly gave his time to the furtherance of the affairs of the Old Students' Association of University College. His qualities cast him for the role of chairman of many boards and committees, the business of which, however contentious, he always kept on the plane of good sense and good humour. In all personal relations, his academic life was a kind of extension of his very happy home life, in which he was husband, father and grandfather. He took little, and gave much, and we who are left will gratefully revere his memory.

Mr. F. B. Stead, C.B.E.

It is with very deep regret that his former colleagues and friends learnt of the death of Mr. F. B. Stead on December 23. He was born on February 19, 1873, the son of the Ven. Samuel Stead, formerly Archdeacon of Bombay. He was a boy at Clifton College, going from there to King's College, Cambridge. At Cambridge he was placed in the first class of the Natural Sciences Tripos and left to become an assistant master at Aldenham School in 1898. In 1901 he returned, as assistant master, to his old school and remained there until 1908. He was made head of the chemistry department at Clifton College in 1908, but left soon afterwards on being appointed one of His Majesty's Inspectors of Schools, an office he occupied for the next twenty-five years, until he retired in 1933.

Stead was made staff inspector on appointment and served in Essex, Surrey and Kent. During the First World War, after being temporarily in charge of Hampshire, he transferred to the Ministry of Munitions. During 1916–18 he acted as secretary to the Prime Minister's Committee on the Teaching of Science, under the chairmanship of Sir J. J. Thomson. After the War he became a divisional inspector of education for seven years, and in 1926 was appointed chief inspector and took charge of the Secondary Branch, then responsible for the inspection of the grammar schools. He was made C.B.E. in 1931. After retirement from the inspectorate he continued for some time as an occasional inspector and even returned to full-time employment for a few months in 1940. He was chairman of the Girls' Public Day School Trust during 1944–48 and since then had been deputy chairman.

One of the most remarkable features of the educational history of Great Britain was the extremely rapid development of grammar school education during the first third of this century. In that development the Secondary Branch of His Majesty's Inspectorate, created shortly after the coming into force of the Act of 1902, played a part the importance of which has not been fully appreciated. Stead joined that Branch early in its history, and seldom was a wiser appointment made. In the first place, not only was he distinguished as a scientist, but also, even more important in view of the work to be done, he was a man of broad general culture who fully realized the dangers of early specialization which beset so many schools in that period. Secondly, sincere and forthright as he was and impatient of loose thinking and sentimental aspirations which so easily beset new developments in education, he was quick to encourage enterprises based on common sense and long and careful study of a situation. Because of this and because of his courage and unselfishness and his immediate and generous recognition of good work wherever he found it, he won the lasting respect and affection, not only of his colleagues, but also of all—administrators, governors and teachers—with whom he had to deal in his twenty-five years of public service.

NEWS and VIEWS

Electrical Engineering in the Imperial College: Prof. A. Tustin

The appointment has been announced of Prof. Arnold Tustin to the newly created University chair of heavy electrical engineering in the Imperial College of Science and Technology, University of London. The appointment carries with it the position of head of the Department of Electrical Engineering in the College and is of especial importance in view of the plans for the expansion of the Imperial College, which have already been widely announced. Financial support has been provided for this chair from the Counterpart Aid Funds. It is intended that the chair of electrical engineering, recently vacated by Dr. Willis Jackson, shall be filled as soon as practicable by a professor of light electrical engineering within the Electrical Engineering Department of the College. Prof. Tustin, who is at present professor of electrical engineering in the University of Birmingham, is well known for his work on automatic control systems and in other fields. He has recently spent a year at the Massachusetts Institute of Technology studying the teaching of engineering, which is one of his many wide interests.

Chemical Engineering at Swansea: Prof. E. S. Sellers

Mr. E. S. Sellers, whose appointment to the newly established chair of chemical engineering in the University College of Swansea has recently been announced, is a graduate of the University of London.

He was first employed in the Lancashire textiles industry and later by the then Anglo-Iranian Oil Co. at Abadan. Mr. Sellers returned to Great Britain in 1938 and joined the staff of the Manchester Oil Refinery, Ltd., and was its refinery superintendent at the time of his appointment in 1948 to a University lectureship in the then newly established Department of Chemical Engineering at Cambridge. Mr. Sellers had previously had some experience of teaching as a part-time lecturer at the College of Technology, Manchester, and from the start was able to play a large part in the planning of the courses and the general organization of the Cambridge School. His research interests have been mainly in the field of distillation processes, including processes operating at very low temperatures. Mr. Sellers has been an active member of the Institution of Chemical Engineers, being on both its Board of Examiners and its Education Committee. He has also been much interested in furthering the co-operation of industry with universities in matters of education, and in the past few years has run two successful 'practice school' courses, first at the Stanlow Refinery of the Shell Refining and Marketing Co., Ltd., and secondly at the Royal Ordnance Factory, Bridgwater. It is expected that he will take up his new duties at Swansea next October.

Geological Society: Awards for 1955

THE Council of the Geological Society has made the following awards for 1955: *Wollaston Medal* to Sir Arthur Trueman for his outstanding and varied contributions to palæontology and stratigraphy and in particular for his palæontological work on the non-marine lamellibranchs of the Coal Measures; this latter work has initiated and led to fundamental advances in palæontology and to the rationalization of British Coal Measures geology; *Murchison Medal* to Dr. C. J. Stubblefield in recognition of his valuable contributions to palæontology and for his work on palæozoic stratigraphy; *Lyell Medal* to Mr. W. N. Edwards, keeper of geology in the British Museum (Natural History), in recognition of his distinguished work in the palæobotanical field; *Bigsby Medal* to Dr. P. E. Kent for his contributions to the palæogeography and stratigraphy of England and Wales and his researches in Central Africa and Persia; *Wollaston Fund* to Mr. J. M. Edmonds for his contributions to the history of geology and the geology of the Oxford district; *Murchison Fund* to Mr. R. Casey for his illuminating work on the Aptian and Albian strata of southern England; a moiety of the *Lyell Fund* to Dr. P. A. Sabine for his petrological work, especially in the Assynt area of Scotland; another moiety of the *Lyell Fund* to Dr. W. Bullerwell for his work in applied geophysics and in particular for his contributions to the gravimetric survey of Great Britain.

Royal Astronomical Society: Awards

THE following medal awards of the Royal Astronomical Society have been made: *Gold Medal*, Prof. Dirk Brouwer, director of the Yale University Observatory, for his outstanding contributions to celestial mechanics; *Eddington Medal*, Prof. H. C. van de Hulst, of the Observatory, Leyden, for his prediction of the 21-cm. line radiation of neutral hydrogen, and for his share in its detection and observation and in the theoretical interpretation of the observations.

Some Exhibits in the Cavendish Laboratory Museum

AN illustrated account of some of the instruments made by Elliott Brothers, Ltd., which are in the Museum of the Cavendish Laboratory, Cambridge, has appeared in the *Elliott Journal* (2, No. 1; 1954). In an earlier article in the same journal (1, No. 1; 1951) reference was made to some of the apparatus constructed for Maxwell, Rayleigh and others by the firm, but a recent rearrangement of the apparatus in the Museum has suggested a fuller account of the more notable Elliott instruments collected there. Maxwell's colour top and his real-image stereoscope are described, and some interesting details are given of his experiments and results using the well-known disk apparatus for the determination of the viscosity of gases, which was constructed for him by Mr. Becker and described in Maxwell's Bakerian Lecture to the Royal Society on February 8, 1866. Maxwell was succeeded as Cavendish professor by Lord Rayleigh, whose research was concentrated on the provision and maintenance of high-precision electrical standards. Elliott Brothers made some of the earliest sub-standard resistance boxes calibrated in terms of the British Association ohm, and later assisted in the re-determination of the ohm by Lord Rayleigh and Mrs. Sidgwick by constructing the well-known spinning-coil apparatus used in that series of experiments. A photograph of the apparatus and references to the original papers are included in the article.

Geological Background of the Iyatayet Site, Alaska

IN 1951 Giddings published his discovery of a blade, core and burin industry, which he called the Denbigh flint complex. This preceded and differed fundamentally from the known Eskimo occupations of Alaska, including the palæo-Eskimo one of which Ipiutak is a part, and its importance is due not only to its age but also to its possible Upper Palæolithic ancestry. A description of the recent geology of the site of the discovery, with an attempt to correlate it with recent deposits elsewhere in Alaska, has been published as a paper by D. M. Hopkins and J. L. Giddings, jun., in Vol. 119, No. 2 of the Smithsonian Miscellaneous Collections (Pub. 4110. Pp. ii+33+4 plates. Washington, D.C.: Smithsonian Institution, 1953). On archæological grounds, the authors believe that the industry is older than the related one, lacking burins, found at Trail Creek, Seward Peninsula, and dated by radiocarbon at about 4000 B.C. Two alternative correlations are suggested: one would give the Denbigh industry an age greater than 10,000 B.C., and the other, which the authors prefer, would date it at about 6500 B.C. The paper illustrates the specialized knowledge required for the interpretation of Quaternary geology in these regions, since it includes such unexpected features as the correlation of forty feet of aggradation in a valley with a period of low rather than high sea-level.

Nitrogen Metabolism of Ripening Fruit

IN a recent study of the nitrogen metabolism of apple fruits, A. C. Hulme (*J. Exp. Bot.*, 5, No. 14, 159; 1954) has found that a close parallelism occurs in the trend of respiration-rate and the ratio protein nitrogen/non-protein nitrogen, both in attached fruits and in fruits harvested at various stages of development and stored for several months at 12° C. In detached fruits the fall in respiration which occurs immediately after picking is only accompanied by a

concomitant fall in net protein in very young fruits in which active cell-division is taking place. Afterwards, in fruit of all ages, when a climacteric rise in respiration occurs, it is accompanied by a net increase in protein. It is argued that the climacteric rise in respiration is a result of increase in the level of protein which will be expected to reduce the adenosine triphosphate/diphosphate ratio. Over the climacteric period, although rate of respiration and net protein content both rise, the former rises more rapidly than the latter and, afterwards, falls at a faster rate than the protein content. It is suggested that this may be due to the 'new' protein containing a higher proportion of enzyme(s) directly involved in respiration and leading, for example, to a reduction in the adenosine triphosphate/diphosphate ratio.

Ophioglossum: Organization in Embryos and Induced Buds Compared

When the sequence and rate of organ formation in embryos and induced buds of *Ophioglossum vulgatum* are compared, some interesting results emerge (C. W. Wardlaw, *Ann. Bot.*, **18**, 72, 397; 1954). In the embryo, the appearance of the primary root considerably precedes the organization of the shoot apex and the formation of the first leaf; but in induced root and shoot buds the reverse is the case. With the limited nutrition provided by the saprophytic underground prothallus, the first leaf of the embryo (actually the second leaf formed) does not appear above ground until after seven to eight years; but in buds induced in decapitated shoots, four to six new leaves may be formed in five to six months. Completely defoliated shoots may show a comparable rate of leaf formation. The conclusion is reached that while the fundamental pattern of development is the same in embryos and buds, the actual sequence in which the primary organs are formed, and their rate of formation and development, are referable to nutritional factors.

Zoological Nomenclature

As from June 30, 1955, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purpose specified against each entry. Full particulars were published on December 30, 1954, in Parts 10 and 11 of Vol. 9 of the *Bulletin of Zoological Nomenclature*. (1) *Dama* Frisch, 1775 (Cl. Mammalia), validation of, for use for the name for the fallow deer of Europe; (2) *Helicella* Férussac, 1821 (Cl. Gastropoda), validation of; (3) *rufa* Linnæus, 1761 (*Formica*), validation of, and designation as type species of *Formica* Linnæus, 1758 (Cl. Insecta, Order Hymenoptera); (4) *Carinifex* Binney, 1865 (Cl. Gastropoda), validation of; (5) *Discias* Rathbun, 1902, *Upogebia* Leach, 1814, *Processa* Leach, 1815, Xanthinae Dana, 1851, Upogebiinae Borradaile, 1903, and Processidae Ortmann, 1896 (Cl. Crustacea, Order Decapoda), validation of. Comments on these cases should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Group Discussion

Over recent years the Central Council for Health Education (Tavistock House, Tavistock Square, London, W.C.1) has published a number of articles in its quarterly journal dealing with various aspects of group discussion in educational, social and working life. These evoked considerable interest and, as a result, the Council has brought them together and published them in book form. They include accounts of the theory and practice of group discussion by Dr. M. L. Johnson, preparation for a group discussion by Dr. Emrys Davies, the technique of running discussion groups by M. Fassam, how to run meetings by J. J. Gillespie and Dr. J. Burton, discussion in a secondary school by Frank Tyrer, the Quaker group by B. Pollard, and group psychotherapy by Dr. E. J. Anthony. There is also a detailed and comprehensive bibliography.

Economic Developments in Mexico

The main article in the autumn issue of *Progress*, the magazine of Unilever, Ltd., describes economic developments in Mexico. It has been contributed by Dr. Eduordo Villasenor, formerly director-general of the Bank of Mexico, who shows that, despite all the difficulties thrown up by the geography of the country, agrarian reform and industrialization are increasing rapidly and are being accompanied by many developments in education and welfare services. Mexicans are particularly proud that their State University, which is the oldest on the American continent, now possesses the "most modern buildings and equipment of any university in the world".

Documentation in Aeronautics

At the fourth meeting of the Documentation Committee of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization in Paris during November 2–6, closer liaison was recommended between the documentation committee and the technical panels of the Group, and in particular it was suggested that the committee might assist the panels in the preparation of bibliographies. Progress was reported in the preparation of the interlingual aeronautical dictionary. A French version of the British Standards Institution's glossary of aeronautical terms was ready for circulation for criticism; a German translation would be ready for revision shortly; Part 1 of a Dutch translation was ready for circulation; and Part 1 of a Russian translation had been revised. It was agreed to produce first individual volumes for each language, with an alphabetical index, for limited circulation in the country concerned for criticism; and not to undertake the preparation of the complete dictionary until criticisms had been received and amendments made. It was also agreed to maintain contact with Dr. Heflin's project for a dictionary of Air Force language.

A sub-committee was appointed to review critically the production of an international abstract bulletin and, if possible, to recommend an alternative approach to the improvement of abstracting services. Subject classification schemes used in aeronautics were also discussed as well as methods of retrieving punched cards, and it was recommended that, in co-operation with Unesco, a list of systems, covering the mechanics as well as methods of coding, now in use in aeronautical fields should be made. Recommendations made at the previous meeting in favour of improving the availability of classified reports were confirmed and a suggestion for the preparation of a guide to the sources of aeronautical information was welcomed. It was also agreed that the adequacy of the translation coverage of aeronautical literature requires close examination, and a draft report is to be prepared for the next meeting.

Recent Developments in Radio Astronomy

A RECENT issue of "Occasional Notes of the Royal Astronomical Society" (3, No. 16; 1954) is entirely devoted to the subject of radio astronomy and is made up of ten papers by Prof. A. C. B. Lovell and his colleagues at the Jodrell Bank Experimental Station of the University of Manchester. A short introduction by Prof. Lovell is followed by two chapters dealing with radio telescopes and techniques, copiously illustrated by plates and a number of diagrams. In these the main principles underlying the use of radio telescopes are explained, and the first chapter ends with a short account of two modern instruments: the large interferometer recently brought into use in Cambridge by M. Ryle; and the pencil-beam radio telescope under construction at Jodrell Bank, which, it is hoped, will be in use in 1955. After this, the remaining eight chapters deal with the application of radio astronomy and are arranged in order of distances from the earth as follows: meteors; radio echoes from the aurora and the moon; radio waves from the sun; radio waves from the galaxy; the identification of the radio stars; the scintillation of the radio stars; radio waves from the interstellar hydrogen; radio waves of extragalactic origin. These provide adequate information for general readers interested in radio astronomy and are well illustrated (there are seven plates and twenty-seven diagrams altogether in the issue), and those who desire more extensive details will find in the bibliography a list of publications during the past eight years, several of which appeared in 1953 and 1954. Two points merit comment here. The first is that the origin of scintillations is not in the source itself but is due to varying atmospheric conditions; and, while these scintillations are very inconvenient to the radio astronomer, they provide a new technique to the geophysicist for investigating the complexities of the upper regions of the earth's atmosphere into which exploring rockets have not yet penetrated. The other is that among the normal nebulæ there may be distributed a class of nebulæ which are more powerful emitters than the normal spirals. It is difficult to say what peculiar property this class possesses, but there is support from different sources for the above suggestion, among which may be noticed the identification by Stanley and Slee of the intense sources in Virgo and Centaurus with the peculiar nebulæ NGC 4486 and NGC 5128, and the more recent identification of the intense source Cygnus 1 with two faint extra-galactic nebulæ in collision. Other lines of evidence also support the suggestion.

Exchange of Students for Technical Experience

THE remarkable increase in the number of technical students who obtain practical experience in other countries during their long vacations is shown in the seventh annual report of the International Association for the Exchange of Students for Technical Experience. During 1954 the number of effective exchanges made has been 4,267 students, showing a further increase of 484 over the 1953 total. In addition, 148 students were placed between Turkey and member countries of the Association. Portugal was admitted to the Association in January 1954, and India and Turkey have made application for admission. Difficulties are being encountered in the United States in forming a central committee for the exchange of students, although many industries have signified their readiness to receive students, and the U.S. State Department has expressed willingness to facilitate the admission of students by the allocation of the necessary programme number to cover the issue of visas for visiting overseas students.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. A. W. Skempton, reader in soil mechanics at the Imperial College of Science and Technology, to the University chair of soil mechanics tenable at that College; Dr. D. G. Harvey to the University readership in chemical pathology tenable at the Royal Veterinary College; Prof. Norman Millott, professor of zoology in the University College of the West Indies, to the University chair of zoology tenable at Bedford College in succession to Prof. H. Munro Fox.

Announcements

THE 1955 James Watt International Medal of the Institution of Mechanical Engineers has been awarded to Dr. Igor Ivan Sikorsky, in recognition of his life's work in applying science to the progress of mechanical engineering through pioneering development of aircraft of various types—multi-engined, amphibians and particularly helicopters. The James Watt International Medal was founded to commemorate the bi-centenary of the birth of James Watt on January 19, 1736, and is the Institution's highest award.

ON the occasion of the Fourth World Petroleum Congress to be held in Rome during June 6–15, an International Oil Equipment Exhibition will be organized in Naples, in the premises of the Overseas Fair (Mostra d'Oltremare). This Exhibition will remain open during June 5–20.

THE group of European molecular spectroscopists, which held meetings at Basel in 1951 and Paris in 1953, has arranged to hold another meeting in Oxford during July 7–11, 1955. The subjects discussed will cover a wide range of ultra-violet, infrared and Raman work. Further information may be obtained from Dr. H. W. Thompson, St. John's College, Oxford.

A CONFERENCE on "The Functions and Education of the Chemical Engineer in Europe", organized by the Institution of Chemical Engineers in co-operation with the Department of Scientific and Industrial Research for the European Productivity Agency of the Organization for European Economic Co-operation, will be held at Church House, Westminster, London, S.W.1, during March 21–23. Eleven Western European countries are expected to take part. The conference is open to official delegates and members of the Institution of Chemical Engineers. Further information can be obtained from the Institution, 56 Victoria Street, London, S.W.1.

THE third annual meeting of the editorial board of the *Journal of Embryology and Experimental Morphology* will be accompanied by a conference on embryology to be held in the Palais des Académies and the Faculté de Médecine in Brussels during April 4–7. Those wishing to attend are asked to inform Prof. A. M. Dalcq, 97 rue aux Laines, Brussels, as soon as possible. (Those travelling from Britain should communicate instead with Dr. D. R. Newth, Department of Zoology, University College, London.) Requests for accommodation in Brussels must be made before February 1.

GENEVA LABORATORY OF THE BATTELLE MEMORIAL INSTITUTE

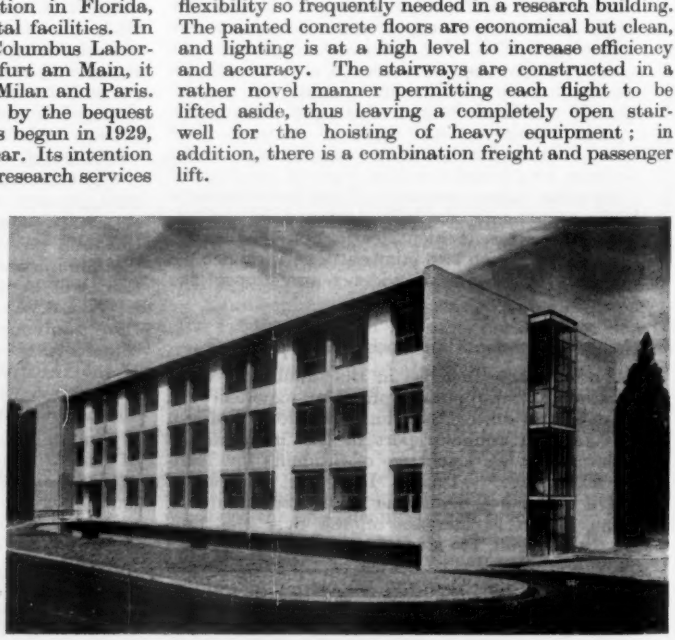
By FRANK C. CROXTON

Assistant Director in Charge of Operations in Europe, Battelle Institute

ON November 26 the Geneva Laboratory of the Battelle Memorial Institute was formally opened before an assembly of three hundred guests from five countries. M. Denis de Rougemont, author and director of the European Cultural Centre, gave an address in which he first explored the reasons for research, described by him as a spiritual passion. After reviewing the need for research, he discussed its purpose, which is the liberation of man by reducing his labours, and said that it is in the creative spirit that research institutes, especially Battelle, must work. Prof. G. Colonnetti, president of the Italian National Research Council, spoke of the benefits to be derived in future years from the peaceful applications of nuclear energy. He reminded his listeners that machines have not caused unemployment but that, on the other hand, man is not yet master of the machine to the extent that he is called on for his intelligence rather than his muscles. He doubted the value of research if the results are applied without concern for their effect on society. Prof. L. Jacqué, professor of chemistry in the École Polytechnique, Paris, described the participation of French scientific workers in the important technical developments of the world and continued by reviewing some of the notable chemical discoveries of recent times. He spoke of several of the research institutions working for the advancement of science and technology and referred especially to organizations such as Battelle and the services that they can render.

The Battelle Laboratory at Geneva is one of three which, with a marine research station in Florida, constitute the Institute's experimental facilities. In addition to its main offices at the Columbus Laboratory and also laboratories at Frankfurt am Main, it also has offices in London, Madrid, Milan and Paris. The Battelle Institute was founded by the bequest of Gordon Battelle, and research was begun in 1929, so that 1954 marks its silver jubilee year. Its intention during this time has been to provide research services of a very practical sort, designed to fit the needs of industry. Although its beginnings were in metallurgy and fuels, the Institute was requested to enter many allied fields, until now it can be said to carry out research and development programmes in essentially all fields of technology. The Institute was originally pictured as of local significance; but as it grew it was soon serving industries from all parts of the United States as well as those of several other countries. It became apparent that Battelle's research services should be made available more generally, and so laboratories were constructed at Frankfurt and now at Geneva. It is doubtful whether Gordon Battelle envisaged the expansion of the contract-research concept to an international scope; but his original ideas of providing research services to industry and thus to mankind have been fully implemented by this step.

The perfectly rectangular building of the new Geneva Laboratory consists of three stories and basement and is situated on a 22-acre plot of land in Carouge, a suburb of Geneva; with it are a villa and a farm building. Immediately after its reconstruction, it was necessary to use the villa for housing the essential requirements; but now it is used for the administrative offices, library and the telephone exchange. The farm building contains the machine shop, carpentry shop and garage. At the earliest possible moment the laboratory building was begun. It was completed only a few weeks before the official opening, but was quickly occupied by the technical staff and their apparatus. This building has a floor area of forty thousand square feet. At one end, the pilot-plant laboratory extends from the ground-floor level to the roof, a height of about thirty-two feet, which permits the installation of tall distillation or extraction columns. The auxiliary apparatus can be placed on the ground floor and on balconies at each of the higher floor-levels. The general laboratories are built on a modular basis. Partitions between them are of non-load-bearing construction to permit removal when necessary for alterations. Hot and cold water, gas and air are available for each unit, as are ducts for hoods where necessary. Both the Geneva and Frankfurt Laboratories use the bus-bar duct system of power distribution which provides the flexibility so frequently needed in a research building. The painted concrete floors are economical but clean, and lighting is at a high level to increase efficiency and accuracy. The stairways are constructed in a rather novel manner permitting each flight to be lifted aside, thus leaving a completely open stairwell for the hoisting of heavy equipment; in addition, there is a combination freight and passenger lift.



Battelle Laboratory at Carouge–Geneva

The Battelle Institute undertakes research for the sole benefit of each client and hands over all results, including patents, the work being carried out on a completely confidential basis. At Geneva, research is being done in physics, chemistry and metallurgy by the staff of eighty-five people. Serious consideration is given to new fields of research as industry demands them, so that, like the Columbus and Frankfurt Laboratories, the Geneva Laboratory is a dynamic rather than a static organization. Each project receives the full attention of the Institute's entire research facilities in the United States and Europe. The volume of research already achieved makes it evident that the Battelle Institute can be as helpful in Europe as it has been in the country of its origin.

THE COLOMBO PLAN: TECHNICAL CO-OPERATION SCHEME

UNDER the Technical Co-operation Scheme of the Colombo Plan, which completed its fourth year in June 1954 (The Colombo Plan. Technical Co-operation Scheme. Report for 1953–54 by the Council for Technical Co-operation in South and South-East Asia. Colombo, July 1954. London: H.M.S.O., 1954. 1*s.* net), training was arranged in 1953 for 608 persons as against 538 in 1952, and 1,653 places have now been provided in all, mostly for graduates with a background of experience which enables them to benefit from their specialist training abroad in various fields of economic development. By June 30, 1954, the largest group (268) went abroad for training in food and agriculture; of the others, training in government administration claimed 266, engineering 192, medicine and health 168, education 135, transport and communications 132, industry and trade 131, and power and fuel 123. The United Kingdom provided facilities for 638 trainees, including 211 from India, 195 from Ceylon and 157 from Pakistan. Of Australia's 487 trainees, 116 came from India, 91 from Pakistan, 80 from Indonesia and 79 from Ceylon. Canada has taken 210 trainees (93 from Pakistan and 92 from India), New Zealand, 170 (45 from Ceylon, 39 from Malaya, 35 from India and 32 from Pakistan), while India has taken 137 trainees, including 67 from Ceylon and 23 from Pakistan. The figures indicate that while Pakistan and Indonesia are concentrating on training in administration, India and Ceylon are concentrating on training facilities in food and agriculture.

The demand for experts has been heaviest in the field of medicine and health. The 58 experts provided in 1953 (compared with 90 in 1952 and 45 in 1951) brought the total provided to 263 as against 502 applied for; and of these, 69 are in medicine and health, 36 in transport and communication, 33 in engineering, 33 in food, agriculture and forestry, 25 in education and 23 in industry and trade. Of the 115 experts provided by the United Kingdom, both India and Ceylon took fifty. Of 45 supplied by Canada, 22 went to Ceylon, 10 to Pakistan and 9 to Malaya. Of New Zealand's 30 experts, 12 went to Pakistan. Although 239 requests were outstanding, offers are still awaited against only 133.

Requests for equipment for use by experts or for training and research institutions since the beginning of the Scheme have totalled £1·5 million, against which equipment to the value of £1 million has been supplied or offered. Requests totalling £714,500 have been received from Pakistan, £591,700 from India and £171,000 from Ceylon. Equipment supplied or agreed in principle by the United Kingdom includes £14,000 worth for the Technical High School, Karachi, and £155,000 for nine new technical high-schools in Pakistan, £50,000 worth for the Mercantile Marine Academy, Pakistan, and £82,000 for the Pakistan Department of Scientific and Industrial Research, £139,000 for the Textile Training Centre, Lyallpur, £70,000 for the National Metallurgical Laboratory, Jamshedpur, £24,000 for the Central Testing and Standards Laboratories at Karachi and Dacca, £37,500 for the Central Water Power, Irrigation and Navigation Research Station, Poona, £12,380 for the Bengal Engineering College, Calcutta, £18,300 for the Research Laboratory of the Forest and Education Branch of the Ceylon Forest Department, £25,000 for the Central Science Teaching Centre, Bandung, and Teacher Training Centres at Djogjakarta and Surabaya.

BIOLOGY AND A GENERAL UNIVERSITY EDUCATION

A CONFERENCE on "Biology and a General University Education", organized by the Institute of Biology, was held at the University College of North Staffordshire, Keele, on December 20–21. Most of those attending were paying their first visit to Keele, and it was clear from what was said at dinner-table and in common rooms that they generally liked what they saw and heard of the College. There was appreciation, too, of the inclusion in the general education for which North Staffordshire stands, not only of biology but also of those traditional academic graces which are so conspicuously lacking in some of the universities born of the industrial revolution.

In the first session, under the chairmanship of Prof. S. Zuckerman, three speakers described biology courses for arts students that are already in existence. Prof. A. R. Gemmell dealt with biology as one alternative for the compulsory natural science subject for students of the humanities or social sciences at Keele. He tries to give his students an insight into the scientist's approach and some knowledge of the nature of laboratory work, to relate the science to the student's own background of knowledge, and to stimulate him to think. The centre of the course is man, and there are fifty-two lectures, on mammalian physiology and anatomy, parasitism and disease, genetics and agriculture. There is a three-hour practical class each week, including dissection of the rabbit and some work with *Drosophila*. Dr. J. Hutchens (Chicago) then described biology as a part of the general education course at his university. Here physical science is studied as well, and before biology, and the students include those who will later specialize in sciences as well as the humanities. The emphasis in the biology course is on the physiology of man; but the laboratory course begins with microscopy—pond water, blood cells and so on—a practice of which Dr. Hutchens does not approve. There are differences of approach in different parts of the course, some stressing details and others general principles. For the most part, the teaching in general education is done by a separate staff from

that of the divisions which deal with higher degrees; this frees research workers whose chief interest is the multiplication of published papers from work which will not lead to their academic advancement, but has the unfortunate effect of making the others, whose job is teaching rather than research, feel somewhat second-class.

Dr. C. Gordon dealt with a course in social biology which he gives to social science students at Edinburgh; this is complementary to one in anatomy and physiology given by a physician. The biology is academic and vocational and includes topics such as man's place in the animal kingdom, the effects of heredity and environment, and some discussion of physiology and vital statistics. The students take an examination at the end of the course, and their answers are on the whole well written but show no evidence of any ability to interpret data. This is partly because the students are frightened of mathematics, but may also be due to the absence of any practical work, which the scientists have not yet been able to induce the board of studies to impose.

In the subsequent discussion, a number of speakers said that they could give a better education if they had students for four years instead of three; but there was no general agreement on the meaning of a fourth year or on what to do with it. For some, it seemed to mean ignoring what the students had done at school or teaching them again what they had already had the opportunity of learning there; for others it meant the possibility of lengthening and strengthening the course for an honours degree. The sense of the meeting was probably that it is a good thing to have a specialist staff to teach science to arts students; but that its members should also take part in straightforward research, and that some form of practical work is desirable.

In the afternoon Prof. Gemmell took the chair, and the conference heard three professors at North Staffordshire say how useful his biology course was for their students. Prof. S. Finer (social science) found its advantage to be that it taught them the background of knowledge of human ecology necessary for their practical work; Prof. W. C. Stewart (education) welcomed it for its aid in the understanding of child development; and Prof. J. Blake (history) liked its broadening of outlook and its development of a different aspect of truth from those with which the historian and philosopher deal. In the absence through illness of Mr. L. J. F. Brimble, Mr. W. B. Yapp (Birmingham) gave the only other set paper in this session, which had the title "Biology for Arts Students—Is it worthwhile?" He suggested that in order for such courses to be justified, there had to be a successful solution of the problem of language, careful selection of topics which are wide in scope but deep in the demands which they make on the students' understanding, and even more careful selection of the teacher. Referring to the theory of organic evolution as probably the best single topic, both on theoretical grounds and in practice, he said that those who taught it to arts students should have a wide background of knowledge and in particular ought to have read "The Origin of Species". This divided the audience, or at least the vocal part of it, fairly evenly into those who had read the book and agreed with the speaker, and those who had not and thought it unnecessary to do so. In the rest of the discussion Prof. T. A. Bennet-Clark (King's College, London) voiced the disappointment of many of the biologists when he said that the three Keele speakers had all spoken chiefly of the value of biology on vocational grounds.

The final session, with Prof. O. E. Lowenstein in the chair, was on "Biology in a General Science Education". Prof. Bennet-Clark defended it as suitable for third-class and pass-degree men who would enter commerce, and felt that a training in science gives a better education, in A. N. Whitehead's sense of "a habitual vision of greatness", than is now possible for the humanities. Prof. F. W. R. Brambell (Bangor) put the case against general science by arguing for the virtues of specialization on educational grounds. He recommended opportunism in the choice of advanced courses, and the pursuit of them to the forefront of knowledge according to the interests of the staff available. Among points raised in the general discussion were the difficulty that early study of the basic sciences often lays down special interests at school (Dr. Gordon); the need for courses not leading to a professional career in biology (Dr. Hutchens); the advantage of an encyclopædic knowledge (Prof. Lowenstein); the importance of knowing when one is ignorant (Mrs. Riddiford); and the value of a biological training in teaching one to deal with complex situations. There seemed in the end to be a greater measure of agreement between the two principal speakers than at first appeared. Both wanted as much specialization as possible for those who could profit from it, and both held that biology had more to offer than its mere vocational value for those who would use it in after life. One of the most pleasing aspects of the conference was the general feeling that a university training in biology can be one of the best preparations for entry to those careers in administration and leadership for which we have not yet designed precise undergraduate courses. Biology, in fact, might well take part of the place so long occupied by the classics but for which they are no longer fitted. One would like to see a full and reasoned statement of this view, which was implicit rather than openly said in much that passed at the conference.

W. B. Yapp

GASEOUS ELECTRONICS

CONFERENCE IN NEW YORK

The Gaseous Electronics Conference has now become an annual meeting in the United States which is greatly looked forward to by all those interested in the subject. The 1954 Conference was sponsored by the Division of Electron Physics of the American Physical Society, and the host institution was the College of Engineering of New York University, which is celebrating its centenary. The meetings were held in New York City during October 14–16, and were attended by about 240 members from all over the United States and Canada. More than a third of the forty-five papers (forty-one contributed and four invited) came from universities, the rest coming from the great industrial laboratories and government establishments, representing in all twenty-seven different organizations. Members of the Conference were entertained at a banquet at which the guest speakers were Dr. T. E. Allibone, of Associated Electrical Industries, Aldermaston, who described current work in England on gaseous electronics, and Dr. W. Finkelnburg, of Siemens-Schuckert, Erlangen, who described present-day

German work in this field. The chairman of the Committee of the Conference was Dr. W. P. Allis, of the Massachusetts Institute of Technology, and Dr. L. H. Fisher, of New York University, as secretary, was responsible for the excellent Conference arrangements.

A very wide field was covered in the papers and it is not possible in this brief report to describe the material in any detail: their subject-matters ranged from atomic cross-sections to the properties of complicated statistical assemblies such as the high-temperature arc. Of late years much work has been done in improving modern vacuum techniques and in the preparation of pure gases and of clean surfaces, and this has led to the re-evaluation of some fundamental ionization and collision data. Among such papers were those of W. H. Hickman and R. E. Fox (Westinghouse) on negative-ion formation using low (0·1-eV.) mono-energetic electrons, the narrow capture process yielding information about the behaviour of such electron beams, and that of E. Gerjuoy (Pittsburg) and S. Stein (Westinghouse) discussing theoretical work on rotational excitations by slow electrons. L. M. Branscomb (Bureau of Standards) described measurements of the photo-detachment cross-section for the hydrogen atom, obtaining a result within 10 per cent of that calculated by Chandrasekhar. N. Wainfan, W. C. Walker and G. L. Weissler (Southern California) reported determinations of cross-sections for photo-ionization of carbon dioxide, argon and the hydrogen and water molecules in the wave-length range 473–1100 A., and of photoelectric yields in the vacuum ultra-violet. The atomic absorption cross-section of atomic nitrogen found by A. W. Ehler and G. L. Weissler agrees with that calculated by Bates. D. J. Rose (Bell Laboratories) reported recent determinations of Townsend's α in hydrogen over the range $20 < Z/p < 1{,}000$ V./cm. mm. mercury, assessing disagreements between previous determinations. H. D. Hagstrum (Bell Laboratories) described determinations of the secondary emission of electrons from surfaces either atomically clean or contaminated by a monomolecular gas layer. With clean surfaces $\gamma_{max.}$ for He^+ is found to be $\sim 0{\cdot}2$ and largely independent of ion energy; but for contaminated surfaces γ increases with ion energy and may become as high as unity. F. Keywell (Bell Laboratories) discussed high-vacuum sputtering. R. N. Varney (Washington) reported work on diffusion, and A. V. Phelps (Westinghouse) described the diffusion and volume-loss coefficients of helium metastable atoms and molecules; and the life-time of metastable mercury molecules was discussed by C. G. Matland and A. O. McCoubrey (Westinghouse).

Another group of papers dealt with the physics of plasma. Plasma oscillations were considered by J. E. Drummond and L. Wilcox (Sylvania); fluctuations in crossed electric and magnetic fields by H. W. Batten (Michigan); travelling striations by N. L. Oleson (U.S. Naval Postgraduate School); noise mechanism by M. I. Skolnik (Johns Hopkins); aspects of plasma resonance by K. S. W. Champion and S. C. Brown, and a microwave study of positive ion collection using probes by G. J. Schulz and S. C. Brown (Massachusetts Institute of Technology); cumulative ionization processes in the helium positive column by L. S. Frost and A. V. Phelps (Westinghouse).

A number of papers dealt with properties of the electric arc. Low-voltage phenomena were discussed by E. O. Johnson (R.C.A.) and extreme temperature phenomena by W. Finkelnburg (Siemens-Schukert). Other aspects of discharge phenomena were described in a session which included an invited paper by H. Margenau (Yale) on the effect of electrons on spectral lines emitted in a discharge, and papers on the cathode spot arc by Robert St. John, J. G. Winans (Wisconsin) and by C. G. Smith (Raytheon). D.C. arcs in a magnetic field were discussed by L. P. Winsor (Rensslaer) and T. H. Lee (General Electric), and R. W. Warren (California) reported measurements of electric fields in glow discharges.

A third of the programme was devoted to papers on electrical breakdown, and, in particular, to the ionization processes by which the ionization builds up on the application of electric fields.

Variation of mean free paths in discharges was considered by I. A. MacLennan and A. D. MacDonald (Dalhousie). Two papers on the influence of field emission on Paschen's law at high pressure and in vacuum phenomena breakdown were given by L. H. Germer, P. Kisliuk and W. S. Boyle (Bell Laboratories). The influence of molecular structure on the sparking potential of hydrocarbon gases was discussed by R. W. Crowe and J. C. Devins (General Electric). A paper by E. L. Huber (California) described work on corona breakdown in nitrogen and oxygen and mixtures, using α-particle triggering. Further experimental evidence on the development of a Townsend avalanche preceding breakdown was given by H. W. Bandel (California) for air; and for argon by M. Menes (Westinghouse), who suggested a process involving delayed photon emission. A session was devoted to a symposium of three invited papers on breakdown. A paper on the mechanism of uniform field static breakdown was given by F. Llewellyn Jones (Swansea, Wales); a paper on the formative time-lags of uniform field breakdown by L. H. Fisher (New York); and a paper on secondary processes and the mechanisms of spark breakdown by L. B. Loeb (California). The ensuing discussion indicated a general agreement on the role taken by the electron avalanche and the secondary ionization processes, and, while helping to clarify terminology, also indicated the field that still awaits complete quantitative explanation—as that of the complete build-up to a high current-density spark-channel after the applied voltage had attained or exceeded the static breakdown potential.

Miscellaneous subjects were dealt with in papers by C. Kenty (General Electric) on metallic flames excited by active nitrogen, by H. P. Broida (National Bureau of Standards) on afterglow of solid nitrogen, and by W. M. Brubaker (Consolidated Engineering Corp.) on space charges in mass-spectrometer ion sources. Probes for space-charge fields were discussed by P. Coopermann (Research Corporation); electronic tuning of microwave cavities by F. R. Arams and H. K. Jenny (R.C.A.); ionization in long nitrogen afterglows by W. B. Kunkel and A. L. Gardner (California); and studies of anode pre-breakdown phenomena in thyratrons were described by S. Goldberg (Edgerton, Germeshausen and Grier, Inc.). Fire-ball discharges were discussed by G. Medicus (Wright Air Development Center) and by K. G. Henquist and E. O. Johnson (R.C.A.).

In closing the Conference, Dr. W. P. Allis mentioned that the general subject for the conference to be held next year will be discharge phenomena at extremely high temperatures.

F. Llewellyn Jones

PRODUCTION OF TOWN GAS BY GASIFICATION PROCESSES

ON September 3 at the recent British Association meeting in Oxford, Dr. F. J. Dent, director of the Gas Council's Birmingham Research Station, read a paper to Section B (Chemistry) on the gasification of coal. He began by pointing out that town gas has most of the properties of an ideal fuel, being smokeless, clean, convenient and amenable to precise control. Its use has increased steadily, until now the heat units distributed as gas are equal to 6 per cent of those in the total coal mined, with an estimated annual saving of more than twenty million tons of coal. At a time when it has never been more important to economize in coal, when everyone is acutely conscious of the evils of air pollution, and when the refinement of industrial processes needs corresponding refinement in methods of heating, it is of prime importance to know whether much more coal could not be gasified so that the use of gas could be extended to general heating purposes. On the grounds of cost alone, this would require the coal to be converted at high thermal efficiency in a relatively cheap plant, and clearly there must be little restriction as regards the type of coal. There must also be flexibility in operation, since the more extensive is the use of gas, the more desirable will it be to suit production to variations in demand.

In the light of recent technical advances it seems that all these requirements will soon be attainable, but only by having some alternative to carbonization, the principal process now used for gas manufacture. The carbonization of coal, operated since gas was first introduced for lighting, is now highly developed; but it has limitations which would probably militate seriously against a further major increase in gas production. To some extent these are due to the cost and inflexibility of the plant; but, more particularly, they are concerned with coal supplies which, for carbonization, must be of a special kind, rich in volatile matter to give sufficient gas, reasonably low in ash, and fusible enough to produce a good coke. But, while all coal is scarce, it is this caking type which is becoming the most difficult to obtain. The plans of the Coal Board are to mine a greater proportion of weakly caking coal, and more mechanization is expected to increase the production of high-ash smalls. These are likely to be the coals most readily available for gas manufacture and, except in limited quantities, they are unsuitable for carbonization. It is for these reasons that a large increase in the production of gas from coal seems to require some other process. We now believe that one with the desired features will soon be obtainable, and it will gasify the coal completely as a result of the initial thermal decomposition being followed by the reaction of residual carbon with steam,

$$C + H_2O \rightarrow CO + H_2.$$

It is as well, however, to appreciate what such a process involves since, clearly, its chemistry is quite different from that of carbonization. A gasification system absorbs the elements of water and does not reject carbon as coke; but yet, for a time at least, the gas finally obtained must be interchangeable with that from existing plants. The gas need not have the same empirical composition as coal gas; but for satisfactory behaviour in appliances, it must be of similar calorific value and density. It must have a calorific value of 450–500 B.Th.U. per cu. ft. and a density of about 0·5 (air = 1).

The composition of coal is then sufficient to show that, in meeting this requirement, besides providing for the straightforward reaction with steam, a suitable gasification process must: (*a*) increase the production of methane above that normally obtained by thermal decomposition so as to give the required calorific value in the greater volume of gas obtained per ton of coal; and (*b*) avoid too high a density in the gas by rejecting both carbon and oxygen. This can be done by converting carbon monoxide to hydrogen by means of additional steam and then removing carbon dioxide,

$$CO + H_2O \rightarrow H_2 + CO_2.$$

Until a few years before the Second World War, these operations always appeared formidable. Indeed, it can be argued that it has been because of them that carbonization has persisted as the basic method of gas manufacture. In 1935, however, the Lurgi process was introduced in Germany and showed that a considerable simplification could be obtained by conducting the whole of the gasification under a pressure of several atmospheres. The Lurgi process uses a generator, similar in design to a normal mechanical producer, except that it allows gasification to be carried out in steam at 20–30 atmospheres. Oxygen is added to the steam to liberate the heat required by the gasification reaction, and the output is readily variable through the rate at which this oxygen and steam mixture is supplied. The unique feature is, however, the use of pressure, which is found to have several advantages: it reduces gas velocities through the fuel bed so that small fuel can be gasified at high output with little loss of dust from the generator; under pressure, methane is stable at the temperature of the fuel bed and is formed during the gasification itself; steam, used in excess to prevent clinker formation, reacts in the fuel-bed with carbon monoxide, and the density of the final gas is quite normal; pressure then facilitates the removal of the carbon dioxide by washing the gas with water or, preferably, with organic solvents, which also eliminate gum formers and sulphur compounds, to give a higher standard of purity than has hitherto been attained in town gas.

This process was initially developed for the gasification of lignite. Large installations have been operated on the Continent of Europe, and more are being erected. It clearly has most of the desired features. In fact, technically, only two further developments are required before its use in Great Britain; and these are, first, a modification of the generator so that it would gasify bituminous coals, which differ from lignite in that they tend to agglomerate when heated under pressure and, secondly, an increase in the calorific value of the gas which, at 400–450 B.Th.U. per cu. ft., is still rather low.

Modifications to the design of the generator have been made in Germany, and tests have shown that it is now capable of dealing with a wide range of British weakly-caking coals. The increase in calorific value has also been achieved, work in Britain having concentrated on this aspect. It has been found that the formation of additional methane under pressure is the result of hydrogen from steam reacting with the coal and that the extent of this hydrogenation

reaction can be increased if the best use is made of the pressure available.

The process can therefore be regarded as satisfactory in so far as it will produce a suitable gas from low-grade coals, and the capital charges are only about half those of carbonization. Are its overall economics also satisfactory? So far as can be ascertained without full-scale trial in Britain, the cost of gas production would, in many localities, be lower than by carbonization but not low enough for the expansion of gas production as contemplated by Dr. Dent. In its present form, therefore, the Lurgi process is mainly to be regarded as a method for widening the range of the coals used for gas-making, and it is important on that account. Is there, however, opportunity for the further development of what is still a relatively new process? Dr. Dent thinks that there is.

Because of the nature of the process, development will not be confined to any single feature. As already indicated, the conversion of coal to gas involves a number of steps, and minimum costs will only be achieved if each is carried out at maximum efficiency. If gas is to be competitive for general heating, production processes must leave no margin of avoidable losses and take full advantage of there being no restriction by natural laws such as those which limit the efficiency of utilizing coal for power generation. Then it is realized that, while a first attraction of the Lurgi process is that the gasification in steam, the conversion of carbon monoxide, and the formation of methane occur in the one fuel bed, the individual performances do not compare favourably with those attained under other conditions, and they are all capable of improvement.

Consideration indicates that maximum performances will only be obtained by having separate control at each stage, and this is quite logical. Efficient reaction with steam requires a high temperature, efficient conversion of carbon monoxide a low one, while the production of methane is favoured by an intermediate range with the partial pressure of hydrogen as high as possible. Optimum conditions for each cannot be obtained in the same fuel-bed, and all experimental work indicates that individual control will improve both efficiency and flexibility. In more detail, developments being considered are: increasing steam decomposition by operating with higher temperatures in the fuel bed, and withdrawing the ash as a slag—the thermal efficiency of gasification will then approach 80 per cent; obtaining the maximum efficiency in carbon monoxide conversion by using catalysts in a separate stage incorporating the removal of carbon dioxide; and enriching the gas by means of the hydrogenation reaction, and again in a separate stage and after steam, carbon monoxide and carbon dioxide have been removed so that the pressure of the remaining hydrogen is as high as possible.

The plant lay-out will then consist of boiler plant, oxygen plant, gasification stage, condensation with rejection of tar and liquor, removal of hydrogen sulphide, conversion of carbon monoxide and removal of carbon dioxide, enrichment stage, and final purification.

This system underlies a programme of research being carried out in Britain by the Gas Council. It will be appreciated that it is more comprehensive than the present Lurgi process and represents rather the full development of pressure gasification for the production of town gas. Thus, while the gasification stage may have standard or slagging generators, it may also include units for the fluidized or suspended gasification of powdered coal, breeze, tar and petroleum oils, as well as for the reforming of natural and other fuel gases, and similarly in the enrichment stage. In fact, once a works has been laid out for pressure gasification with oxygen, steam supplies, etc., it would be relatively simple to effect modifications in the gasification and enrichment stages to suit any raw material. Further, whatever raw material were used, the composition of the final gas could correspond with any calorific value up to 1,000 B.Th.U. per cu. ft., a fundamental feature characteristic of pressure operation, as reactions can be governed by equilibria at every stage; this is different, for example, from a process of thermal decomposition such as carbonization, in which so much depends upon the nature of the coal. As in Lurgi gas, there would be only four simple gas constituents—namely, carbon monoxide, hydrogen, methane and nitrogen—but now, with the proportions of each constituent under full control, the methane determines the calorific value, the ratio of hydrogen to carbon monoxide determines the output, and the nitrogen controls the gas density. Eventually, there might be no restriction to the present properties of coal gas, and then gas composition could be chosen to suit distribution and use.

When it is coal that is being hydrogenated in the enriching stage of the system outlined above, the solid residue might be transferred to the gasification stage for the production of hydrogen-rich gas. It should be noticed, however, that during hydrogenation, most of the sulphur in the coal is removed and recovered as hydrogen sulphide, and the residue contains only 0·1–0·2 per cent of this constituent. Being also readily combustible, the residue might therefore find other applications; for example, as basis of a solid smokeless domestic fuel or as a fuel for power stations, when the flue gases would no longer call for treatment.

The significance of pressure gasification is due to its adaptability in so many directions which embrace most, if not all, of the production features that have been sought at various times. With this unique characteristic, it goes far beyond the immediate requirement for an alternative to carbonization, and offers a unified system of gas-making capable of suiting any foreseeable circumstances. If the gas industry is to become the purveyor of refined heat for general purposes—a greater part than it has played in the past—then it needs some such system to facilitate the assumption of its wider function, opportunity for which has been increased by the broader groupings set up in Britain by nationalization. Particular mention might be made of the high rates of gasification obtained under pressure, which allow high outputs from individual gas-making units without an increase of the labour force, while, more obviously, the distribution of gas over longer distances at the high pressures would allow manufacture to be concentrated in large works, sited with respect to supplies and raw materials, whatever they might be. Finally, the overall cost of gas production on the basis of heat units should be little more than twice the cost of pithead coal. Taking into account its greater efficiency in use, its high purity and its convenience, this should make gas competitive with solid fuel for a wide range of heating purposes, and it is therefore believed that gas will satisfy a far greater proportion of the demand for smokeless fuel than is generally

contemplated. Then, with production of an overall thermal efficiency of approximately 80 per cent, there will be a considerable saving in coal.

The technical developments which have been envisaged are not regarded as aims for the distant future. Vigorous investigations of gasification processes are being carried out in various parts of the world, and much is now known of the use of oxygen, slagging operation, powder techniques, hydrogenation, oil gasification and so on. What remains to be done consists mainly of selecting those elements which lead to the highest performance and integrating them into the pressure system. Without minimizing the effort required for this final stage, it is nevertheless believed that, with the Lurgi process as a basis on which to build, a flexible system of gas production could be made available in a few years.

MEDICAL RESEARCH COUNCIL

REPORT FOR THE YEAR 1952–53

A FEATURE of the report for 1952–53 of the Medical Research Council* is an article entitled "Medical Research in the Tropics", which discusses the origin and work of the Colonial Medical Research Committee set up eight years ago by the Secretary of State for the Colonies and the Medical Research Council, under the chairmanship of the Secretary of the Medical Research Council. During the eight years since the establishment of this Committee, new centres of research have been built at Fajara in the Gambia, Mwanza in Tanganyika, Oshodi in Nigeria, Kumba in the Cameroons, and Kerugoya in Kenya, and the Rockefeller Foundation generously transferred to the Colonial Office its virus research institutes at Entebbe in Uganda and Yaba in Nigeria. Research laboratories were built at Makerere College in Uganda, and support was given to research in Malaya and to work on malaria in Tanganyika. The Committee also advised that a Colonial Medical Service should be created, and, although this was instituted in 1949, recruits to it have been slow in coming forward.

Recently, however, the control of this Colonial research has been reorganized. It is not easy to disentangle from the paragraph describing this reorganization exactly what has been done; but the new arrangements provide "for decentralising to inter-territorial bodies the immediate scientific supervision of research schemes based in the colonies" and a "home-based organisation will continue to centre on the Colonial Medical Research Committee, whose terms of reference have been revised to accord with the newer concept of its duties". One is tempted to wonder, as one reads and tries to understand exactly how this complex organization works, which seems to the authorities to be the more important—the administrative machine or the men and women, at home and abroad, on whose devoted and unpublicized labours the whole organization, and also the health of a great many people, depend.

The rest of the Council's report follows the plan adopted during the past few years. It does not attempt to record the results of the work of the Council's separate research establishments, but gives only brief summaries, in the form of headings, of the work of each department. For further information the reader is referred to the bibliography of papers published by individual research workers. The practice now is to discuss, under the title "Some Aspects of Medical Research", selected general trends of medical research "often from a broader standpoint than that of the contributions made by work within the Council's own programme", a practice which "inevitably omits mention of many investigations in which the Council's workers take part".

Following this practice, the present report discusses, in the section on "Some Aspects of Medical Research", high-altitude research and the Everest expedition, cell metabolism, peripheral nerve injuries, the diagnosis and treatment of virus diseases, the grafting of tissues, the biosynthesis and metabolism of some simple nitrogenous compounds, high blood pressure, the use of cortisone and adrenocorticotropic hormone in rheumatic diseases, studies of twins, hazards in the use of pesticides, the use of hypothermia in surgery, and lipid metabolism. The section is a valuable one; but some readers, however much they welcome contributions of this kind, will regret that it is no longer possible to have reports of the work being done by individual workers. G. LAPAGE

* Committee of Privy Council for Medical Research: Report of the Medical Research Council for the Year 1952–1953. (Cmd. 9184.) Pp. v+269. (London: H.M.S.O., 1954.) 7*s*. 6*d*. net.

FORESTRY IN THE GOLD COAST

REPORT FOR THE YEAR 1952–53

THE report for the year 1952–53 of the Forest Department of the Gold Coast* gives evidence that under the new governmental régime in the Gold Coast the forests and their well-being are not to be neglected. Twenty years ago the gazetted forest staff numbered twelve officers, mostly stationed in the south, the northern territories scarcely coming into forestry consideration by the forestry authorities. At present, so the Chief Conservator of Forests states, the sanctioned Colonial Forest Service is thirty-five officers. In addition, the sanctioned subordinate staff consists of twenty-four senior forest rangers and a hundred and twenty forest rangers with the necessary complement of forest guards. Such a trained staff will, it may be hoped, be continued under the new government.

The report shows most satisfactory progress. The formation of a working plans branch, concerned with the enunciation of the approved forest policy, points to this. In the report for 1948–49 (see *Nature*, 167, 598; 1951) it was stated that a new and detailed forest policy formulated in 1946 had been formally approved by the Governor in Council and that one of the chief aims was the management of permanent forest resources by methods that would achieve maximum productivity on the basis of a sustained yield. This is a familiar aspiration, often repeated in the past in forestry reports; but the Department is making considerable progress towards its fulfilment. The policy is briefly summed up under one heading—reservation—most of which has reached completion except in the Northern Territories. Management over 4,583 square miles of forest reserves has now been covered by enumeration surveys, mainly on a one per cent basis of sampling, and a working plans branch was set up during the year, the total area of reserves under working plans being 880 square miles.

* Gold Coast Government Report on the Forestry Department for the Year 1952–53. Pp. ii+24. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1954.) 2*s*. 6*d*. net.

Under research, sylvicultural research work in the high forest zone has reached a successful stage which will enable results to be placed at the disposal of the working plans branch. Under local authority forestry the introduction of a new system of local government has necessitated a revision of the forest reserve rules and by-laws. Here the necessary amendments have been made in order to enable alterations in the by-laws to be made. The destruction of forest land by farming has increased owing to the high price offered for cocoa; it is estimated to have been 780 square miles a year, and the amount of high forest outside forest reserves now remaining is assessed at 6,327 square miles. Most damage has been done in Ashanti. No control of this farming has yet been achieved, and it is altogether a great blot on the administration in Africa generally—under other governments besides the British.

Three other facts emerge from the report. The control of timber concessions is under the chief conservator of forests. Secondly, plans have been made for the expansion of the training of the subordinate staff which it was hoped to bring into force in 1954. Finally, advice is always available on technical subjects to mining companies and others on the establishment and management of fuel and pole plantations upon which progress is being made in many parts of the country. E. P. Stebbing

J.-S. BAILLY, AN EIGHTEENTH-CENTURY FRENCH SAVANT

In a publication entitled "Jean-Sylvain Bailly, Astronomer, Mystic, Revolutionary, 1736–1793" (*Trans. Amer. Phil. Soc.*, N.S., **44**, Part 1, 427–538; 1954. From the American Philosophical Society, Independence Square, Philadelphia 6, Pa.; 6 dollars), Edwin Burrows Smith gives an account, including a very comprehensive bibliography and index, of one who was a statesman, astronomer and savant. A member of the French Academy and of the Academy of Inscriptions, Bailly was president of the Third Estate and of the National Assembly and was Mayor of Paris during 1789–91. This meteoric career came to an abrupt end soon after his retirement at Melun, where he was seized, charged with conspiracy and executed in 1793.

Born into an essentially artistic milieu, Bailly abandoned the arts to study Newtonian physics, became a respected astronomer and won wide recognition throughout Europe for his research on Jupiter's satellites. Later on, however, he concentrated on the historical side of the subject, and between 1775 and 1787 he published five large volumes on the history of ancient and modern astronomy. In addition, in three smaller works he tried to retrace the course of man's development, and supported the theory of a primitive golden age. Although his scholarly works brought him many public honours, not only in France but also in four other European countries, he nevertheless found himself involved in a number of scientific and literary quarrels, largely because of his wild speculations on antiquity. Perhaps it was fortunate that he took part in the investigations of Mesmer's pretensions regarding animal magnetism, because this brought him back into contact with controlled scientific inquiry in which men like Franklin, Lavoisier, Guillotin and others played a prominent part, so that after the autumn of 1784 mesmerism rapidly disappeared from Paris, though it continued to be practised in the provinces.

The study of Newtonian physics led Bailly to the belief that scientific precision could be extended to other fields of human knowledge, such as history, law, language, etc., and this view led to a breach with the sceptical philosophers who had little confidence in systematic explanations of immaterial or intangible phenomena. As the author of this biography remarks, "Bailly fell victim to the hobgoblin of *vraisemblance*"; in other words, in cases where truth could not be demonstrated, he was prepared to accept the probable explanation. The French Revolution represented the acid test for Bailly's philosophy, for that was the period when the theorist could try the practical application of his ideas, and Bailly's ideas did not survive the test. At the end of the biography, the author pays a tribute to his public work, in spite of its lack of success: "The remarkable aspect of Bailly's public life is not his failure, but the fact that he succeeded so well in coping with the practical problems which were so far removed from his cognizance".

A DETAILED RADIO MAP OF THE SKY

By Prof. J. D. KRAUS and H. C. KO
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From observations during the spring of 1954 with the Ohio State University radio telescope, a detailed radio map of the sky has been made. This map (Fig. 1) has sufficient detail to suggest how the sky would appear if our eyes were sensitive to radio waves instead of light. The central region of our galaxy or Milky Way system stands out prominently, as do also a number of localized radio sources such as Cassiopeia *A* and Cygnus *A*.

The contours are lines of equal radio brightness as observed at 250 Mc./s. with the 96-helix antenna of the Ohio State University radio telescope. The observations were made by setting the antenna at a fixed declination for several days. As the earth rotated, a record or profile of the cosmic radio background was then obtained as a function of right ascension for a narrow zone of declination. Scores of such profiles taken at other declinations were combined to produce the map. The co-ordinates are right ascension (α) and declination (δ) (1950.0) and the contours give the apparent radio brightness in units of 10^{-25} W. m.$^{-2}$ (c./s.)$^{-1}$ deg.$^{-2}$. The map gives the observed levels, not being corrected for the antenna pattern. Thus, a minor lobe of the antenna appears as a small rise near the preceding sides of the strong sources Cassiopeia *A* and Cygnus *A*. The elongated shape of these sources is a direct measure of the antenna pattern, which is a fan-beam 1° wide between half-power levels in right ascension by 8° in declination at 250 Mc./s. The minor lobes and elongated shapes are imperfections in the radio map that are analogous to the defects in an image seen with an optical telescope due to the aberrations of the lens. Since the map is a Mercator projection, a localized source near Dec. 0° such as Virgo *A* appears as a more slender ellipse than does a source more remote from the equator such as Cassiopeia *A*.

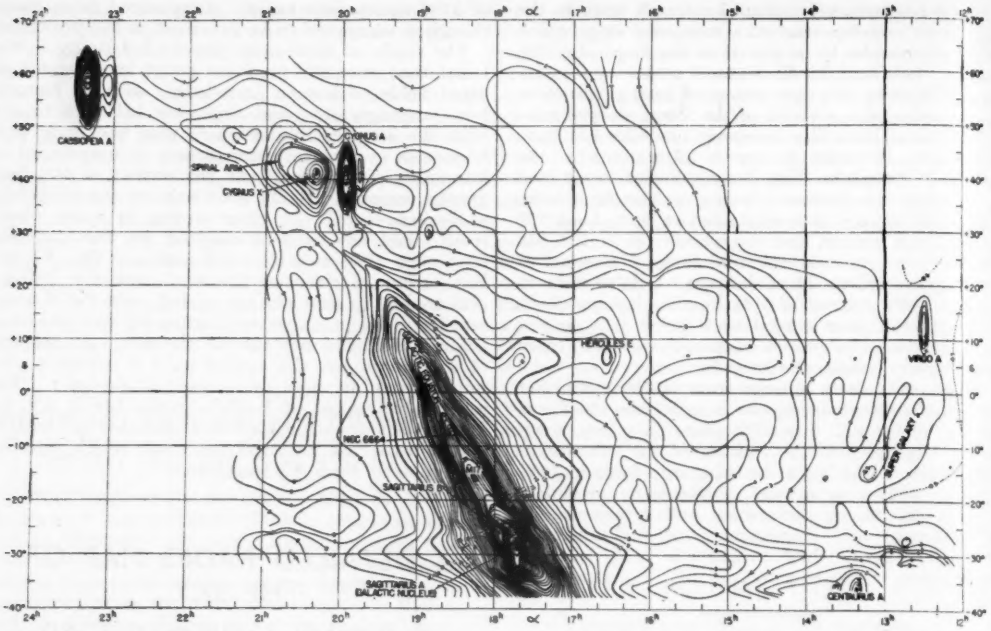

Fig. 1. Map showing the apparent radio brightness of the sky as observed at 250 Mc./s. The contours are lines of equal radio brightness (radio isophotes). Cassiopeia *A*, Cygnus *A*, the central region of our galaxy and its nucleus (Sagittarius *A*) stand out as intense sources. A number of weaker sources are also indicated

Although records were taken continuously, twenty-four hours a day, usually only those obtained during the early morning hours were sufficiently free from interference (solar and terrestrial) to be usable. Thus, the map is restricted to the region between R.A. 12^h and 24^h. The region north of Dec. $+65°$ is not included, due to interference, while that south of Dec. $-40°$ is either close to or below the horizon. Observations are in progress to extend the map to the entire sky observable from Columbus, Ohio, that is, north of about Dec. $-40°$.

In addition to such well-known sources as Cassiopeia *A* (peak value 46) and Cygnus *A* (peak value 37·5), the map also reveals a number of extended sources such as the one coinciding with the plane of the supergalaxy[1,2] in the region between the localized sources Virgo *A* and Centaurus *A*. The latter source is actually below the lower boundary of the map (at Dec. $-43°$) but its presence can be deduced from the deviation of the nearby contours.

In constructing the map each profile was arbitrarily adjusted to the same zero or reference-level for all declinations along a line near R.A. $11^h\ 30^m$, the minimum brightness being near this line. Thus, the map may be subject to a slight distortion which would appear chiefly as a small gradient in declination. Also, since the minimum background-level is finite, not zero as assumed, all contour-levels on the map should be increased by this minimum brightness (of the order of 8 map units) in order to give the absolute brightness-level.

Although numerous radio contour maps of the sky have been published, the resolutions have been insufficient to reveal much detailed structure. Two exceptions are the recent maps by Hanbury Brown and Hazard[3] of the Cygnus region and by McGee and Bolton[4] of the region near the galactic centre, both made with $2° \times 2°$ beams. However, both these maps cover only relatively small regions of the sky.

The highest elevation on the map, designated Sagittarius *A*, is presumably the galactic nucleus; it stands out as a sharp spire (peak value 65) superimposed on the general galactic background. The centre of our galaxy is obscured by dust from optical observation, so that a direct observation of the position of the nucleus is of much importance. The equatorial co-ordinates (1950.0) of the galactic nucleus as determined from the map are:

R.A.: $17^h\ 42^m\ 48^s \pm 15^s$; Dec.: $-28°\ 50' \pm 30'$.

The corresponding galactic co-ordinates (Ohlsson) are:

$$l = 327{\cdot}8°\ ;\ b = -1{\cdot}4°.$$

Haddock, Mayer and Sloanaker[5], with a $\frac{1}{2}° \times \frac{1}{2}°$ beam at 9·4 cm. wave-length, report a position for this source of $17^h\ 42^m\ 30^s \pm 12^s$ and $-29°\ 01' \pm 5'$. The agreement of the positions is within the error of measurement.

Longitudinal and transverse profiles through the galactic nucleus as obtained from the map are presented in Fig. 2. The ordinates are the relative intensity (or relative brightness). Fig. 2*a* shows the intensity in the plane of our galaxy expressed as a function of galactic longitude at a constant galactic latitude of $-1{\cdot}4°$. Fig. 2*b* shows the intensity at right angles to the galactic plane expressed as a function of galactic latitude at a constant galactic longitude of $327{\cdot}8°$.

From the galactic nucleus, which rises as a sharp peak at $327{\cdot}8°$, the longitudinal profile (Fig. 2*a*) has a gradual decrease to about $360°$ with a somewhat more rapid falling off beyond. This change in slope is probably related to the fact that from about $330°$ to $360°$ radiation is observed from the inner spiral arms

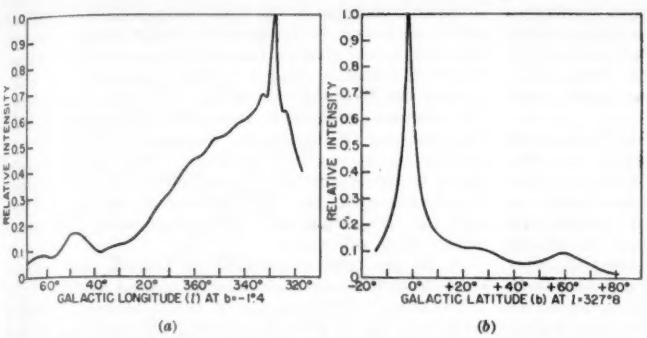

Fig. 2. (*a*) Longitudinal and (*b*) transverse profiles through the galactic nucleus showing the observed relative radio intensity as a function of the galactic longitude and the galactic latitude

of our galaxy. From 360° to 40°, and beyond, the direction of observation is outside the inner spiral arms and the intensity falls off more rapidly except for a small peak at about 48°. This peak is presumably caused by radiation from the spiral arm in which we are situated being observed inwardly along the arm.

Fig. 2*b* reveals the thin structure of our galactic disk as viewed in transverse section. However, residual radio intensity is seen to extend out to large galactic latitudes with small peaks near the galactic latitudes of 30° and 60°.

This work has been supported by grants from the Development Fund, the Lovejoy Memorial Fund, and the Research Foundation of the Ohio State University and also by a grant from the National Science Foundation. [Sept. 29.

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POSSIBLE SITE AND MODE OF ACTION OF CERTAIN LIPOTROPIC MACROMOLECULES IN TUBERCULOSIS

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IT has been reported that certain macromolecular detergents are effective chemotherapeutic agents against tuberculous infection in mice[1] and in guinea pigs[2]. More recently, Cornforth, Hart, Nicholls, Rees and Stock[3] have shown that the antituberculous effect is confined to members of these series having a high lipophilic/hydrophilic ratio, and that as this ratio is decreased therapeutic activity is reduced and then reversed, so that the more hydrophilic members actually enhance the infection ('protuberculous' effect). The detergents are prepared by forming the polyoxyethylene ethers of a high molecular-weight condensate of *p-tert*-octyl-phenol and formaldehyde. Unfortunately, these antituberculous compounds cause liver damage in animals after prolonged use and cannot at present be considered for use in man. This discovery, however, has stimulated further studies to determine the site and mode of action.

Cornforth *et al.*[1] showed that the detergents were stable *in vivo* and remained within the circulation of the animals for many days. It appears that the activity is a property of the intact substance and is not due to metabolic products of its breakdown *in vivo*[2]. The agents are neither bactericidal nor hæmolytic *in vitro* even at concentrations as high as 2·0 per cent. It seems, therefore, that their activity depends upon some disturbance of the host–parasite relationship rather than a direct toxic action upon the bacteria. This idea receives support from the observation of Hart, Long and Rees[4] that these therapeutically active detergents produce a definite though limited depression of the tuberculin response in tuberculous and BCG-vaccinated guinea pigs. The first indication of a site of action of these substances came from the experiments of Mackaness[5], who showed that suppression of growth of the tubercle bacillus occurred within the host phagocytic cells. Monocytes from rabbits treated for several days previously with one of the chemotherapeutically active agents readily ingested virulent tubercle bacilli, but in contrast to the monocytes of untreated animals, there was little or no multiplication of the bacteria afterwards. Monocytes from untreated animals were not rendered inhibitory to the growth of ingested virulent organisms by the mere suspension of the phagocytic cells in a solution of detergent *in vitro*.

These last observations encouraged experiments to determine whether or not the antituberculous agents actually penetrate the monocytes *in vivo*, and if so to what concentration, and whether they are free or adsorbed upon the surfaces and structures of the cell. Assuming that the detergents do penetrate the cells and are present free at high concentrations, the possibility arises that they might be rendering the organism vulnerable to the destructive agencies of the phagocyte by stripping or modifying a protective lipid outer layer. Experiments, reported here, upon the action of the different detergents towards the hæmolysis of human red cells by thermal shock have a bearing on this point, for the sensitivity of red cells towards hæmolysis on sudden cooling is strongly dependent upon the composition of the lipids of the cell membrane[6,7].

Site of Action

Monocytes were obtained from the peritoneal cavity of mice 24 hr. after the intraperitoneal injection of 0·2 ml. of a mixture of equal parts of 40 per cent 'Lemco' and 20 per cent gum acacia. The monocytes were harvested by washing out the peritoneal cavity with 1 ml. of heparinized saline containing 2 per cent albumin. An equal volume of 0·01 per cent suspension (containing particles of approximately 1 μ in diameter) of victoria blue, *B*150, was added to the monocyte suspension, and the mixture was then vigorously shaken and in-

cubated at 37° C. Samples were removed at 5-min. intervals and examined under the microscope either as hanging-drops or in slide-cells. The monocytes examined in this way were obtained from mice treated with one of the antituberculous agents and from untreated control animals.

The cells from both the control and the test animals were observed to have ingested the dye particles freely. After a short time, however, the particles within the test macrophages were seen to dissolve and produce discrete circular patches of blue; later the blue patches merged and the whole cell was coloured uniformly. By contrast, the dye particles within the control macrophages remained intact with no trace of dissolution throughout the course of observation. The quantity of dye taken into solution by the detergent was found, by separate experiments, to be directly proportional to the concentration of detergent over the range 0·001–10 per cent. Assuming that the quantity of dye dissolved by a given concentration of detergent is the same within the cell as it is in the test-tube, it is possible to calculate very approximately from the depth of colour of the cell the concentration of detergent it contains. A saturated solution of the dye in 0·01 per cent of a typical therapeutically active detergent gives a blue colour which is only just visible in a layer 100 μ thick. Assuming the thickness of the macrophage is approximately 10 μ, this suggests that the concentration of the detergent within the cell is at least 0·1 per cent, for the cell was visibly blue and it is not certain that sufficient dye had been ingested to saturate the detergent within it.

These experiments suggest that, not only does the cell contain a high concentration of the detergent, but also that it is uniformly distributed with it and is freely available for the solution of the dye and lipid material ingested by the macrophage.

Mode of Action

The macromolecular detergents under discussion are not tuberculostatic *in vitro*, even at concentrations as high as 2·0 per cent. The properties of tubercle bacilli grown in their presence are, however, altered. Most of these detergents promote dispersed submerged growth rather than the normal granular formation[5]. Virulent strains of tubercle bacilli which normally decolorize methylene blue very slowly in the presence of glucose, using the Thunberg–methylene blue technique, do so rapidly when therapeutically active detergents are added (Rees, unpublished work). These effects suggest that the superficial lipid layers of the organism are somehow modified in the presence of these detergents. This might result either from the adsorption of the detergent on to the surface of the organism, or by the solution of lipids from the bacteria within the detergent micelles.

Red blood cells, like tubercle bacilli, have a predominantly lipid outer layer. It is possible to produce modifications in the quantity and proportion of lipids in the membrane of the red blood-cell without causing irreversible damage[6]. Thus the red blood-cell can lose as much as 20–30 per cent of its lipids without hæmolysis. Therefore, although the detergents under consideration are not hæmolytic even at concentrations as high as 2·0 per cent and for periods of exposure as long as 1 hr. at 37° C., this absence of hæmolysis does not necessarily indicate that the cells are unaffected by the exposure. The most simple and sensitive method of determining reversible changes in the lipid composition of the red cell membrane is to observe their sensitivity to thermal shock, that is, hæmolysis on sudden cooling, which is directly related to the proportion of cholesterol to phospholipid in the red cell membrane[7]. The removal of lecithin from the cell increases, and the removal of cholesterol decreases, sensitivity to hæmolysis by sudden cooling. This system thus offers a convenient test for the effect of the different detergents upon the lipid membrane of the red cell and for comparing any such effect with that upon tuberculous infection.

A 10 per cent suspension of human red cells in 0·16 *M* sodium chloride was incubated at 37° C. for 1 hr. with concentrations of the detergents ranging from 0·05 to 10·0 mgm. per ml. At the end of this time an equal volume of 2·4 *M* sodium chloride, also at 37° C., was added to the suspension. After a further 5 min. at 37° C., the tube containing the cells was transferred to a mixture of crushed ice and distilled water and there left for 10 min. The chilled suspension was centrifuged, and the extent of hæmolysis measured in terms of the light absorption of the hæmoglobin released into the supernatant.

Fig. 1 shows the effect on thermal shock of one series of detergents, which were all derived from the same parent resin (*p-tert*-octyl-phenol formaldehyde resin) and are designated by the average number of ethylene oxide units added to each phenolic hydroxyl group of the resin. In the absence of any detergent, 50 per cent of the cells were destroyed by thermal shock. The detergents with ten or twenty ethylene oxide units considerably decreased, whereas the one with thirty units slightly decreased, the severity of the damage by cooling at the lower concentrations used. The detergent of this series with sixty ethylene oxide units increased the damage by thermal shock at all concentrations, and that with ninety units of ethylene oxide only slightly increased the damage. On the other hand, a polyethylene glycol with a molecular weight of 4,000 had practically no effect upon thermal shock.

These results demonstrate that the surface of the red cell is modified after exposure to the detergents. Their interest becomes greater, however, when they are compared with the activity of the detergents

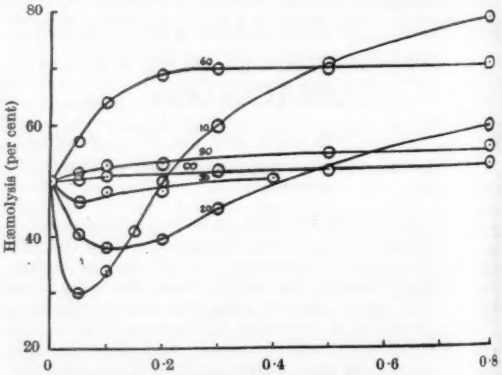

Fig. 1. Effect of exposure for 1 hr. at 37° C. to a homologous series of detergents upon the sensitivity of red cells in 1·2 *M* sodium chloride to hæmolysis by sudden cooling from 37° to 0° C. The detergents tested had 10, 20, 30, 60 or 90 ethylene oxide units per phenolic hydroxyl group. Polyethylene glycol, molecular weight 4,000, is included also to represent a detergent with an infinite number of ethylene oxide units

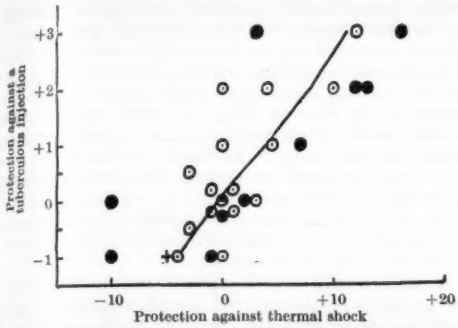

Fig. 2. Comparison of the effect of various agents upon the sensitivity of red blood-cells to thermal shock (expressed as percentage change in sensitivity at a detergent concentration of 0·1 mgm./ml.) and upon a tuberculous infection in mice. The detergents tested included those derived from a linear macromolecule of *p-tert*-octyl-phenol formaldehyde condensate (●), a macrocyclic tetramer of the same condensate (⊙), suramin (+) and a block copolymer of ethylene and propylene oxides ('Pluronic *F*68') (⊖). The curve shows the mean activities towards thermal shock in red cells for each class of activity towards infection

towards infection with tuberculosis *in vivo*. The detergents with ten and twenty units of ethylene oxide are both antituberculous, the one with thirty units is inactive and the detergents with sixty and ninety units are 'protuberculous'. The polyethylene glycol is inactive. Thus there is a broad correlation between the activity of the detergents towards thermal shock *in vitro* over the concentration range 0–0·2 mgm./ml. and their activity towards infection.

Fig. 2 compares the activities of twenty-five macromolecular detergents both towards infection with tuberculosis and thermal shock in red blood-cells. Mice are infected intravenously with a virulent human strain of *Myco. tuberculosis* (*H37Rv*) and treated intravenously with the agents on the first, fourth and eighth days after infection. The effect of each agent on the course of infection is assessed from the median survival times in the treated and control groups, and its effect in preventing or enhancing infection is finally graded as an arbitrary score between + 3, 2 or 1 (antituberculous), inactive (0) and ('protuberculous') − 1, respectively. The effect in reducing or increasing thermal shock was measured by the technique already described. The results shown in Fig. 2 are the hæmolysis after thermal shock in 1·2 *M* sodium chloride following exposure for one hour at 37° C. to 0·1 mgm. of detergent per ml. of solution. Another type of macromolecular detergent, a block copolymer of ethylene and propylene oxides, 'Pluronic *F*68' (Wyandotte Co., Michigan), and a negatively charged high molecular-weight substance, suramin (urea derivative of the aminonaphthalene-sulphonic acid series), are also included for comparison. The block copolymer is inactive in both systems. Suramin, on the other hand, has been shown to enhance a tuberculous infection in mice (Hart and Rees, unpublished work). This substance remains intact within the circulation for long periods, and furthermore it is concentrated in monocytes[9]. It is therefore of considerable interest that this substance is active in both our systems, enhancing a tuberculous infection and increasing the sensitivity of red blood-cells to thermal shock.

Discussion

The experimental evidence suggests that the detergents are concentrated *in vivo* within the monocytes and that they are present within the cells in sufficient concentration and in a suitably free condition to 'solubilize' lipids ingested by the cell. The correlation between the activities of the different detergents towards thermal shock in red cells and towards infection with tubercle bacilli suggests that the activity of the detergents is connected with their ability to modify the membrane lipids of the organism while it is within the macrophage. Some light on the possible changes which could occur in the membrane lipids of the tubercle bacillus also comes from the experiments with red cells.

The behaviour of the detergents towards red cells is consistent with the notion that the detergents with few ethylene oxide units adsorb or displace cholesterol preferentially from the membrane of the red cell, and detergents with many ethylene oxide units adsorb or displace phospholipid preferentially from the envelope of the red cell. This is because the sensitivity of the cell to thermal shock is proportional to the ratio of cholesterol to lecithin in the cell membrane. Preliminary chemical analysis of the lipids of the red cell after exposure to the detergents also lends support for this notion.

If the detergents affect the tubercle bacilli and red cells in an analogous manner, then it might be expected that the detergents with few ethylene oxide units per molecule would remove or displace the more hydrophobic lipids of the organisms preferentially. This would conceivably render the bacteria more sensitive to digestion within the phagocytic cells. The 'protuberculous' activity of the detergents with sixty ethylene oxide units could in a like manner be due to the removal of displacement of the more hydrophilic lipids preferentially, thus rendering the lipid layer of the bacterium even more resistant and impermeable than it is normally. These ideas are also supported by the observation that the character of growth and permeability of the organism are changed in the presence of the detergents.

These suggestions are put forward tentatively to provide a working hypothesis for testing other substances. It is realized, of course, that even if the suggestions are correct there are other ways in which the host–parasite relationship could be altered by the presence of macromolecules within the phagocytic cells; for example, the suppression or enhancement of enzymic activity of the cell or parasite or both.

Whatever is the precise mechanism of action of these agents, it seems very probable that their activity is primarily dependent upon their ability to become concentrated within the monocyte cells, which are themselves known to play an important part in the natural infection.

We are indebted to Dr. P. D'Arcy Hart for his interest and advice; to Dr. J. W. Cornforth and Dr. G. A. Nicholls for preparing the series of detergents; and to Imperial Chemical (Pharmaceuticals), Ltd., for the victoria blue *B*150. [Oct. 1.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Use of Electronic Digital Computers in Optical Design

Electronic digital computers in Britain and the United States have been used for the tracing of rays at high speeds through optical systems. The larger machines have enough auxiliary storage, either magnetic drum or tape, to accommodate enormous amounts of information, so that it is possible to carry out extensive numerical investigations concerning lens systems.

During the past year, experiments have been carried out using the University of Manchester electronic computer in the automatic design of optical systems. The optical design problem has been regarded as a minimization problem of a single function φ, which has been called the performance function, with respect to the variable constructional parameters of the system.

The problem is a special one in that the variable-function system is largely ill-conditioned and non-linear, but is less extensive than the general problem because the n-dimensional surface concerned has certain known properties due to its optical nature. The performance function φ has been constructed by summing the squares of the maximum moduli of certain blocks of aberration residuals with appropriate scaling or weighting factors. Performance numbers of this sort have no optical significance whatever; they simply relate to the state of the geometrical aberration residuals at points in the minimization process. The precise nature of the function φ does, of course, determine the distribution of residuals at the conclusion of any minimization process; but its nature becomes less important as the calculated residuals become smaller.

Until the present time four principal machine minimization processes have been employed. They are iterative within themselves and iterative with respect to each other. The processes are briefly as follows.

(*a*) *Variable-by-variable minimization.* Here variables are taken singly and adjusted by adding or subtracting small increments to each in turn. The large auxiliary storage of the Manchester machine allows one to store all inter-surface ray-tracing data, so that if a parameter in the middle of a system is altered, the ray-tracing data immediately preceding the altered parameter are 'picked up' and the performance number evaluated very rapidly. If a change in a variable results in an increase in φ, then the sign of the increment is changed and φ recalculated. Should the value of φ fall on any parameter change, then the new value of the parameter is retained and control moves to the next variable in the block or series.

Variable-by-variable minimization is extremely rapid (a 'run' on the surface curvatures of a 'Tessar' takes about twenty minutes machine time), and can be regarded as the basic unit relaxation process of automatic design.

(*b*) *Block relaxation.* What is required at the close of the variable-by-variable process is a method of altering the refraction conditions associated with each variable while the general composition of the system is appreciably unaltered, so that the variable-by-variable process can continue with advantage.

Lens 'bending' can be likened to a block operation of numerical relaxation, it being effected by adding (or subtracting) small equal increments to the surface curvatures of a given lens. In optics, however, the increment is chosen with the particular purpose of improving the overall distribution of residuals.

Automatic block operations can be carried out automatically on from two to n variables with two purposes in mind, namely, to reduce the latest value of φ directly, and to change the refraction conditions associated with each variable.

A particularly useful optical block operation is that made by adding small equal increments to all variable parameters, so that the system receives a 'kick' in a certain direction. Throughout this operation and the following operations described, attention must be paid to the configuration of the rays. If the nodal points of the system are taken as reference points, then after each block operation these must be redetermined so that the extra axial rays pass through all systems in a constant manner. In this way only will the resultant values of φ be strictly comparable.

(*c*) *Group operations.* In some cases the variable-by-variable method followed by various block operations leads to an optical system which has a set of residuals all less than those of the original or some intermediate system. It is a simple matter in these circumstances to carry out an optical group operation which is in fact an extrapolation from two systems to a third (usually) better system, that is, to a system which has a still lower value of φ. Group changes can always be made with advantage unless the present lowest value of φ is at a true topographical minimum.

Since the number of variables changed in group operations is considerable and the individual increments generally small, the relation between the extent of the operation and the change in the residuals is largely linear. This fact allows one to 'forecast' a set of residuals without actually calculating them by precise ray-tracing—provided that all 'reference' systems have constant focal length, and an exactly similar ray configuration.

(*d*) *Random operations.* The Manchester machine has a useful facility by which a series of twenty random binary digits are produced by a noise generator; using certain logical instructions, it is possible to add (or subtract) increments to a completely random selection of variables. Should the same parameter be selected p times, then that particular parameter receives p equal increments. If the value of φ is already low, the general tendency of this random process is to increase φ. The main advantage of increasing φ by random methods is that systems can be evolved for use in group relaxation methods already mentioned. The random process is in fact used for testing whether or not the latest lowest value of φ is in fact a true topographical minimum value.

A programme which incorporates all these methods has been used with success at Manchester. Considerable improvement has been achieved on a 'Tessar' lens which has been in use for many years. The improvement was carried out in a little more than two hours.

It is hoped that a full account of this work will appear elsewhere. I am grateful to the Ministry of Supply for permission to publish this work; thanks are due to the Director and Council of the British

Scientific Instrument Research Association, under the auspices of which the work was conducted, under contract to that Department. Thanks are due to those physicists and mathematicians with whom I have enjoyed stimulating discussion, notable among whom are the late Dr. A. M. Turing, Mr. Brooker and Dr. Hoskin, of the University of Manchester; Dr. H. H. Hopkins, of the Imperial College, London; and Mr. Bracey, of the above Association.

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An Interpretation of the Long-Spacing Intensities of Calcium Stearate Monohydrate

THE interpretation of powder patterns of soaps and other long-chain aliphatic compounds which cannot be obtained as single crystals is not easy and is usually ambiguous[1]. Samples of calcium stearate monohydrate prepared by D. Wallace using the method of Vold, Hattiangdi and Vold[2] were recrystallized from solution in a mixture of propylene glycol and chloroform. The recrystallized soap was in the form of very tiny laths which could be formed into highly orientated sheets by sedimentation or by flotation. Such a specimen, mounted on a glass plate, used in a Geiger-counter diffractometer, gives rise to the long-spacing peaks of spacing $d = 50{\cdot}30$ A. from planes parallel to the plane of the specimen and no other peaks.

The intensities of the reflexions were measured to order 30. No reflexions were found beyond this, although observations were continued beyond order 40. The higher-order reflexions were weak and digital counting was necessary for detecting and measuring them. The intensities, corrected for geometrical factors and sharpened, were used to calculate the linear Patterson function. This showed a prominent group of peaks centred at 17 A. from the origin, probably indicating that in the structure there are two molecules separated by 17 A. more or less parallel to their length. This model, assuming that the projection on the long-spacing axis is centrosymmetric, was used for the calculation of structure factors and the corresponding Fourier projection. The Fourier projection was refined using a semi-quantitative difference method[3], and it was soon evident that the position of the water molecule, in projection, must be the same as that of the calcium atom. The final observed and calculated Fourier projections are shown in Fig. 1(*a*) and the corresponding suggested molecular arrangement in Fig. 1(*b*). Apart from the 'hole' at $z = \frac{1}{2}$ which is not present in the calculated Fourier projection, the agreement is good. The principal peaks and the trough at $z = 0{\cdot}32$ corresponding to the end of the molecule are satisfactorily reproduced in both projections.

The nature of the proposed structure with two molecules separated by 16·8 A. parallel to their length restricts ionic bonding between molecules to one direction only, unlike the two-dimensional ionic sheets observed in the soaps of monovalent metals.

The powder pattern can be indexed tentatively as a monoclinic unit cell using the methods of Vand[4], with $a = 5{\cdot}70$ A., $b = 6{\cdot}81$ A., $c = 50{\cdot}4$ A., $\beta = 94°$ and possible space group $P2_1$. The observed and calculated densities are 1·07 and 1·04 gm. cm.$^{-3}$ respectively.

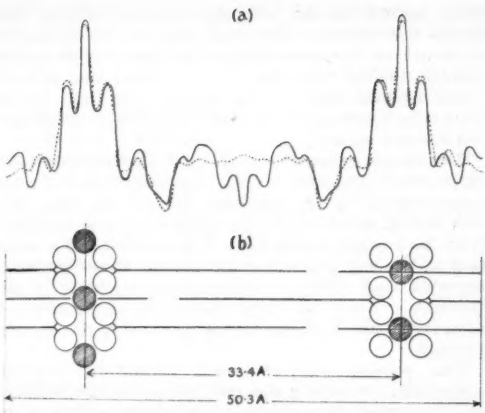

Fig. 1 (*a*) Fourier projection on the long-spacing axis: the continuous line is obtained using the observed structure factors, the broken line using the calculated structure factors

(*b*) Possible type of structure corresponding to Fig. 1 (*a*). Calcium atoms, oxygen atoms and hydrocarbon chains are represented by shaded circles, open circles and straight lines respectively. The water molecules have not been included in the diagram

The direction of the ionic bonding may be that of the *a*-axis, which is similar in length to the *b*-axis found by Vand, Lomer and Lang[5] in potassium laurate. The molecular cross-section of 19·8 A.^{2} is greater than in potassium and silver soaps. This may be due partly to the restriction of the ionic bonding to one direction.

This work was supported by the U.S. Office of Ordnance Research under contract *D.A.* 04–495 *ord*303. I am grateful to Drs. M. J. Vold and R. D. Vold for the many stimulating discussions during the course of the work, which was done during the tenure of a Fulbright Travel Grant and a University of Southern California Fellowship.

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Formation of Compact Pieces of Grey Tin

IN a recent communication on this subject, Groen[1] described a method of preparing large pieces of grey tin by transforming an alloy of tin containing about 2 atomic per cent of mercury. Experiments have been proceeding in this Department with the same end in view, and the purpose of this communication is to describe a possible explanation of this result.

In pure tin, the β–α transformation results in the formation of grey tin as a friable powder. This condition is the result of cracks, arising during the volume expansion associated with the formation of the α-(grey) tin phase. Examination of partially transformed specimens has shown that the cracks may be classified into two groups. The first group appear between the islands of grey tin; the second

group appear in an irregular manner within the islands themselves. The first type of crack can be explained on the assumption that grey tin is mechanically weaker than the white; when two islands of the α-phase meet on the surface, the next layers to be transformed just beneath the surface lever the two islands apart.

Microscopic examination of the surface of a partially transformed specimen reveals that each island of α-tin is surrounded by an extensive field of slip lines and kink bands, again due to the surface stresses resulting from the volume expansion. The density and coarseness of the slip lines increase as the transformation proceeds, and result in macroscopic buckling of the specimen. Since the grey tin is keyed to the α–β boundary, this buckling causes fracture of the weaker α-phase.

This second type of crack formation may be suppressed by raising the yield stress of the β-phase, and the most convenient way of doing this is by alloying. Indentation hardness tests at room temperature showed that whereas the Vickers Pyramid Hardness number of pure tin was 6·7, that of an alloy containing 2 weight per cent of mercury was 19·8. When this specimen was transformed, few slip lines were observed, and buckling was absent. Cracks of the first type still appeared between the islands; these cracks cannot, of course, be suppressed by this means, but the individual islands were strong and compact. Other alloys with a suitable strength should yield the same result.

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Structural Breakdown of Cement Pastes at Constant Rate of Shear

For the thixotropic breakdown of materials with time at constant rate of shear, Weltmann[1] proposed the law:

$$B = -(\mathrm{d}U/\mathrm{d}t).t, \qquad (1)$$

as a result of her work with a rotation viscometer. In this equation U is plastic viscosity, t is time from the start of the experiment and B is the coefficient of breakdown with time.

Green and Weltmann[2] extended this work and proposed that the thixotropic properties of a material be measured in terms of the three quantities B, M and V, where M is the coefficient of thixotropic breakdown with rate of shear and V measures the change in yield value with decreasing plastic viscosity. V is expressed as:

$$V = -\mathrm{d}f/\mathrm{d}U, \qquad (2)$$

where f is yield value; but Shapiro[3] has shown that V is simply the value of the rate of shear corresponding to the point of intersection of the various down-curves.

It may be shown[4] that under the conditions of Green and Weltmann's experiments, where the rate of shear in a rotation viscometer was increased in equal small steps at equal intervals of time, the constants M and B are one and the same. Further, all the equations derived theoretically by Green and Weltmann may be obtained from Weltmann's law alone, without making any further assumptions.

If yield value is considered to be constant (which was found to be the case by Weltmann, at constant rate of shear), Weltmann's equation may be integrated and written for the rotation viscometer as:

$$T = -B \ln t + \text{constant}, \qquad (3)$$

at constant rate of shear and where T is the torque at time t.

In experiments with a rotation viscometer on the structural breakdown of Portland cement/water pastes at constant rate of shear, I have found[4] that this equation agrees with experiment only over a limited range of torques, points taken after a few seconds deviating widely from it. For cement pastes, the decrease in torque can be well represented by the equation:

$$T = T_E + (T_0 - T_E)\exp(-B't), \qquad (4)$$

where T_0 and T_E are the initial and equilibrium torques. This equation is superior to Weltmann's in fitting the experimental results and has the additional merit of giving a meaning to values of T for $t = 0$ and $t = \infty$ which Weltmann's equation fails to do.

In Weltmann's results, her plot of T as a function of $\ln t$ inevitably ignores the value for $t = 0$, and in the case of a pigment suspension D for which she gives full results[1], the next point, for $t = 7$ sec., does not fall on the line. The first point which is approximately on the line, at $t = 16$ sec., occurs when 70 per cent of the total drop in torque has already taken place. A plot of $\ln(T - T_E)$ against t, on the basis of equation (4), gives two intersecting straight lines. Similar results are obtained by plotting Weltmann's results on oils[5] by this method, whereas using her method gives curves of various shapes.

Equation (4) may be derived theoretically[4] by considering the work done in a rotation viscometer and making the assumption that the 'excess torque' $T - T_E$ is proportional to the number of linkages existing. According to this theory,

$$B' = (2\pi K\omega^2)/\varphi, \qquad (5)$$

where ω is the average rate of shear, φ is the work done in breaking a single link and $K\omega$ is the constant of proportionality between $T - T_E$ and the number of linkages. It follows that B' is a linear function of ω^2. The experimental results were found to conform fairly well to this prediction. They were not adequate to determine the dependence of the constant $(2\pi K)/\varphi$, and hence of φ, on the concentration of the paste, but further work is being done on this point.

In this theory no account was taken of any tendency for a rebuilding of the structure, and it was found that for cement pastes there is no such tendency, at least in a time of the order of that taken for an experiment. In this respect this material differs from those with which Weltmann worked, and it cannot be classified as thixotropic.

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Benzoin as a Fluorescent Reagent for the Detection of Germanium

RECENTLY, we[1] have described a fluorometric method for the detection and determination of germanium, making use of resacetophenone in sulphuric acid or phosphoric acid medium. The test is quite specific, except for the interference of boron. In view of the similarity of the germanic and boric acids thus found, we have investigated the use of other reagents which form fluorescent compounds with boric acid. The reagents described in the literature are flavonols[2], 1-amino-4-hydroxy anthraquinone[3], O-hydroxy carbonyl compounds[4] and benzoin[5]. Among the many compounds tested by us the following have been found to be definitely useful: (1) ω-methoxy resacetophenone, phloro-acetophenone, 4-methoxy-2-hydroxy-benzaldehyde, β-resorcylic aldehyde and salicylaldehyde, which give a greenish-yellow fluorescence; (2) 2-methoxy-3:6 dihydroxy acetophenone, 2-benzoyl-phloroglucinaldehyde and 4-methoxy-2-hydroxy-benzoic acid, which give a yellow fluorescence; (3) β-resorcylic acid, orsellinic acid and ethyl orsellinate, which give a violet fluorescence with germanic acid in concentrated sulphuric acid medium.

We have observed that the benzoin reagent described by White and Neustadt[5] for borate also functions as a very sensitive reagent for the fluorometric detection of germanate. It is noteworthy that germanate gives with the benzoin reagent an intense greenish-yellow fluorescence, whereas borate is reported to give a greenish-white fluorescence, beryllium a yellow-green fluorescence and antimony a purplish fluorescence. Zinc gives a green fluorescent compound with benzoin only in the presence of magnesium ions and sodium hydroxide. No other metal or anion is found to give fluorescent compounds with the benzoin reagent. We have found that nitrite, chromate and arsenate quench the fluorescence, whereas silicate somewhat intensifies the fluorescence. Fluoride and nitrate, which quench the fluorescence of germanic acid with the resacetophenone reagent previously described by us, have no effect on the fluorescence with the benzoin reagent.

The fluorescence test with the benzoin reagent is carried out as follows. A saturated solution of recrystallized benzoin in rectified spirit is prepared by shaking an excess of the substance with the solvent at room temperature (28° C.) and filtering; to 5 ml. of this reagent in a quartz test-tube is added 1·0 ml. of a slightly alkaline solution of germanate solution and the mixture made up to 10 ml. with the addition of more rectified spirit. Then the quartz test-tube is exposed to the filtered ultra-violet light from a 'Cenco' black-light source operated on 220 volts a.c. mains. A greenish-yellow fluorescence is observed even when germanium is present in an amount of 10 γ. The limit of sensitivity has been found to be 1:100,000. It is evident that the benzoin reagent is more sensitive than the resacetophenone reagent previously described by us. Moreover, benzoin is a reagent easily available, and the method involves its use in alcoholic solution, which is more convenient to handle than the concentrated sulphuric acid medium required for resacetophenone.

We have also observed that the germanate fluorescence with the benzoin reagent persists even after two hours, unlike the borate fluorescence which is described as lasting only for a few minutes by White and Neustadt. The solution, however, acquires a yellow colour on keeping. The benzoin reagent offers possibilities for the fluorometric determination of microgram quantities of germanium.

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Chemical Properties of a Plasma Factor accelerating Hæmoglobin Recovery in Bled Rabbits

IT has been shown that plasma of repeatedly bled rabbits—referred to here as 'anæmic plasma'—contains a factor (or factors) which accelerates the recovery of hæmoglobin concentration after a standard hæmorrhage[1] and produces a greater reticulocyte response in receptor animals[2]; when injected repeatedly into normal rabbits, 'anæmic plasma' significantly increases the hæmoglobin concentration, red cell and reticulocyte counts[3]. After boiling 'anæmic plasma' at *p*H 5·5, the supernatant, separated from the precipitated proteins, is inactive[1].

In this communication we present data showing that the factor responsible for the activity of 'anæmic plasma' can be extracted from the heat-coagulated plasma proteins, with either water or acetone, and we describe some of the steps taken to purify it.

Rabbits were used as experimental animals. The extracts were tested for activity by their effect on the speed of hæmoglobin recovery[1] after a standard hæmorrhage (1 per cent of body-weight). All extraction processes were carried out in an atmosphere of carbon dioxide, as it is possible that oxygen diminishes the activity of 'anæmic plasma'[1].

Fig. 1 shows the recovery from a standard hæmorrhage of rabbits injected with isotonic sodium chloride, normal rabbit plasma, water extract and acetone extract of the coagulated proteins of 'anæmic plasma'. The acceleration of the recovery of hæmoglobin concentration in animals injected with the extracts of anæmic plasma can be noted; the difference from the controls is statistically significant ($P < 0{\cdot}01$).

Using the same biological test, we have been able to show that the factor in 'anæmic plasma' can be dialysed through 'Cellophane'; that oxygen diminishes the activity of acetone extracts; that the active portion of the dried acetone extracts taken up in chloroform and passed through a standardized alumina column is retained in the top third, whence it can be extracted with acetone. It is possible to repeat the chromatography on columns three times without loss of activity. The active factor in the acetone extracts can be precipitated from aqueous solution with basic copper carbonate, and it is possible to recover the activity from the precipitate by chloroform extraction. It has also been noted that the active factor of 'anæmic plasma' is carried down with both the albumin and globulin fractions after treatment with ammonium sulphate.

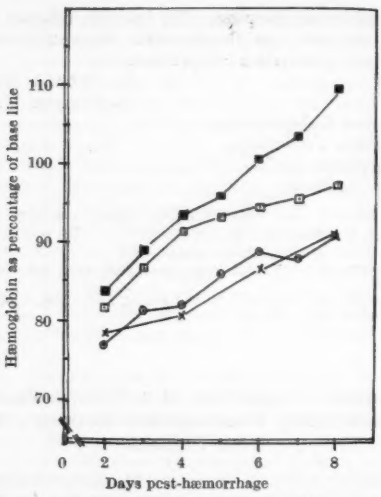

Fig. 1. Mean values for hæmoglobin concentration as a function of time, after a standard hæmorrhage (1 per cent body-weight), in the following groups. ×——×, 14 rabbits injected with isotonic sodium chloride; ○——○, 16 rabbits injected with normal rabbit plasma; ⊡——⊡, 9 rabbits injected with water extract of 'anæmic plasma'; ■——■, 4 rabbits injected with acetone extract of 'anæmic plasma'

The purified acetone extract of 'anæmic plasma' shows (Fig. 2) an absorption spectrum in the ultra-violet, similar to that of the extract of 'anæmic urine'. It is interesting to note that exposure to oxygen—which diminishes the activity of the extract—changes the ultra-violet absorption spectrum notably. However, further chemical purification is necessary before it can be determined whether the ultra-violet absorption spectrum is characteristic of the active factor in 'anæmic plasma' or is due to impurities.

Preliminary chemical studies, carried out on purified acetone extracts, show that these only give a positive colour reaction with sudan IV (fatty acid esters) and negative reactions with ninhydrin (amino-acids), mercuric nitrate reagent (purines), and ammoniacal silver nitrate (sugars) on Whatman No. 1 paper.

Our observations suggest that the factor isolated from 'anæmic plasma' is not identical with the 'erythropoietic hormone' isolated by Contopoulus *et al.*[4] from sheep anterior pituitary, which is probably a polypeptide.

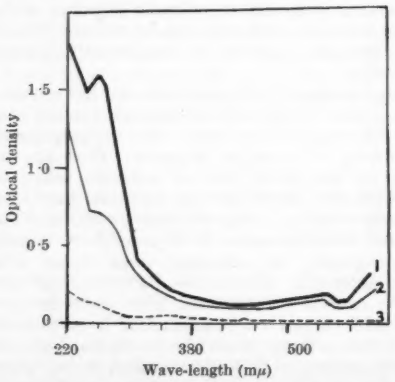

Fig. 2. Ultra-violet absorption curve of purified acetone extract of 'anæmic plasma'; curve 1 before, and curve 2 after, exposure to oxygen. Curve 3 refers to a blank experiment

Further details of the extraction processes and results of the biological tests will be published elsewhere. This work was aided by a grant from the Consejo de Investigación Científica de la Universidad de Concepción. We thank Messrs. A. Fernández and H. Varela for technical assistance.

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Reconstruction of Coupled Phosphorylation in the Succinic Oxidase System

Calcium ions are known to inhibit oxidative phosphorylation in isolated mitochondria. As reported previously[1], in the case of substrates oxidized via diphosphopyridine nucleotide, this inhibition can be reversed by the addition of the pyridine nucleotide, adenosine triphosphate and manganous ions. Treatment with the pyridine nucleotide alone partially restores only the respiration; but addition of all three factors is necessary in order to re-establish both oxidation and phosphorylation.

The phosphorylation accompanying the oxidation of succinate to fumarate is likewise inhibited by calcium treatment; but, since pyridine nucleotides are not involved in this reaction, the oxidation does not become dependent on the addition of the co-enzyme. Calcium treatment thus produces a mitochondrial system catalysing the single-step oxidation of succinate. The addition of adenosine triphosphate and manganous ions to such a system results in a coupled phosphorylation at a phosphorus to oxygen ratio (moles of esterified phosphate to atoms of oxygen consumed) of about unity.

Mitochondria were obtained from rat liver, homogenized in sucrose–versene (0·25 and 0·01 *M*, respectively) and washed once with the same solution. The preparation from one liver was suspended in 20 ml. of a saline-buffer solution (*p*H 7·5) containing potassium chloride, potassium phosphate, adenylic acid and glucose, in concentrations specified in Table 1. The suspension was supplemented with yeast

Table 1. Effect of Calcium Ions on the Oxidation of Different Substrates in Rat Liver Mitochondria

Each Warburg vessel contained: substrate, 30 micromol.; ortho-phosphate, 76 micromol.; adenylic acid, 5·7 micromol.; glucose, 200 micromol.; potassium chloride, 230 micromol.; magnesium chloride, 10 micromol.; yeast hexokinase (prepared and diluted as described in ref. 1), 0·1 ml.; calcium ions (where indicated), 1·15 micromol. *p*H 7·5. Final volume, 2·5 ml. Gas phase, air. Temp., 30° C. Substrate added from side-arm after 5 min. of incubation. Total incubation time, 29 min.

Substrate	Respiration (microatoms oxygen)	
	Calcium ions absent	Calcium ions present
α-Ketoglutarate	24·6	2·3
Succinate	28·7	21·7
Fumarate	12·4	1·0

Table 2. Effect of Adenosine Triphosphate and Manganese Ions on Phosphate Esterification coupled to the Oxidation of Succinate to Fumarate in Rat Liver Mitochondria treated with Calcium Ions

Experimental conditions as in Table 1. Succinate (30 micromol.), adenosine triphosphate and manganese ions added from side-arm after 5 min. incubation. Total incubation time, 25 min.

Additions at 0 time	Additions after 5 min.		Phosphorus to oxygen ratio
Calcium ions (1·15 μmol.)	Manganese ions (1·5 μmol.)	Adenosine triphosphate (μmol.)	
–	–	–	1·70
+	–	–	0·12
+	–	0·1	0·07
+	–	0·2	0·07
+	–	0·5	1·03
+	–	1·0	1·02
+	+	–	0·05
+	+	0·1	1·10
+	+	0·2	1·17
+	+	0·5	1·12
+	+	1·0	1·09

hexokinase and magnesium chloride and diluted with isotonic potassium chloride to 25 ml. 2 ml. of this suspension was pipetted into Warburg vessels and incubated for 5 min., before addition of the substrate from the side-arm.

If this pre-incubation is performed in the presence of calcium ions (5×10^{-4} *M*), the system loses its ability to oxidize those substrates requiring the participation of pyridine nucleotides, while it is still capable of oxidizing succinate. This is illustrated in Table 1. The nearly theoretical molar relationship between succinate and oxygen consumed (Fig. 1) substantiates the fact that we are here dealing with the single-step oxidation of succinate to fumarate.

In the above system no esterification of orthophosphate accompanies the one-step oxidation of succinate (Table 2). The effect of added adenosine triphosphate and manganous ions is shown in this table. Adenosine triphosphate alone, when added in sufficiently high concentration (the factors determining this critical concentration of adenosine triphosphate are under further investigation), induces a phosphorylation at a maximum phosphorus to oxygen ratio of about unity. Manganous ions alone, at the concentration tested, had no effect; but the involvement of manganese in the phosphorylative mechanism is indicated by the fact that it potentiates the effects of limiting concentrations of adenosine triphosphate.

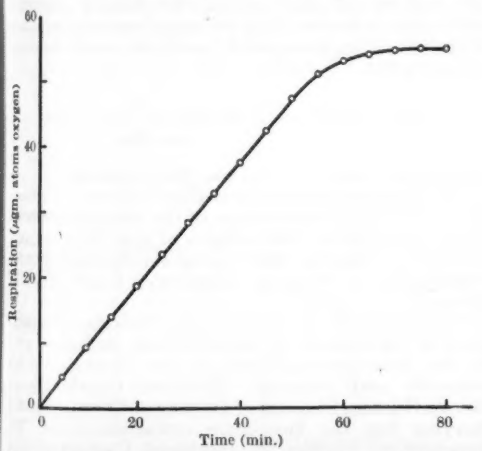

Fig. 1. One-step oxidation of succinate in rat liver mitochondria treated with calcium ions. Added succinate, 50 micromol. Other experimental conditions as in Table 1

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Inactivation and Activation of Liver Phosphorylase

The level of phosphorylase in liver slices represents a balance between inactivation and resynthesis of the active form; epinephrine and glucagon rapidly increase the amount of active phosphorylase in pre-incubated liver slices[1,2]. In order to study the nature of the change in the phosphorylase molecule, liver phosphorylase and the enzyme inactivating it from dog liver have been prepared in purified form. The liver phosphorylase was purified approximately 400-fold, a value higher than previously reported[3]; this purified enzyme was very soluble in water and when inactivated enzymatically showed little or no activity when tested in the presence of adenylic acid. The inactivating enzyme from dog liver was also purified about 400-fold, and this purified enzyme was sufficiently active for microgram quantities to be used in most experiments. Preliminary tests using several proteins as possible substrates have revealed no proteolytic activity.

In searching for possible small fragments released during inactivation, liver phosphorylase inactivated enzymatically was dialysed and the dialysates were analysed. Phosphate was found in the dialysate of liver phosphorylase fractions incubated with the inactivating enzyme, and identical values were found when measurements were made for stable phosphate, or for phosphate as determined by the method of Fiske and SubbaRow[4], or by the Lowry–Lopez method[5]. The phosphate present in the liver phosphorylase was not released when liver phosphorylase was precipitated with cold trichloroacetic acid, so subsequent analyses were conducted by sampling reaction mixtures into trichloroacetic acid and measuring phosphate released enzymatically in the trichloroacetic acid supernatant. Fig. 1 shows the results of such an experiment where the enzymatic inactivation of liver phosphorylase is accompanied by a release of phosphate. 9·5 mgm. of liver phosphorylase in 1·3 ml. of water was incubated with and without 0·038 mgm. of inactivating enzyme (IE), which had been purified approximately 400-fold. At the times indicated along the solid lines, 0·01-ml. aliquots were removed and were assayed for liver phosphorylase activity in a test system which contained adenosine-5-phosphate. At the times indicated along the broken lines, 0·2-ml. aliquots were treated with trichloroacetic acid, and the supernatants after centrifugation were analysed for phosphate. Results are expressed as micrograms of phosphorus released per 9·5 mgm. of liver phosphorylase. The inactivating enzyme alone released no measurable amount of phosphate into trichloroacetic acid supernatants.

Using both the dialysis and trichloroacetic acid precipitation techniques, about 0·25 μgm. phosphorus was found to be released per milligram of liver phosphorylase, or 31 gm. phosphorus per 124,000 gm.

liver phosphorylase. Preliminary studies using several other phosphorus-containing compounds, such as *p*-nitrophenyl phosphate, α-glycerophosphate, or sodium pyrophosphate, showed no phosphate to be released by the inactivating enzyme from liver.

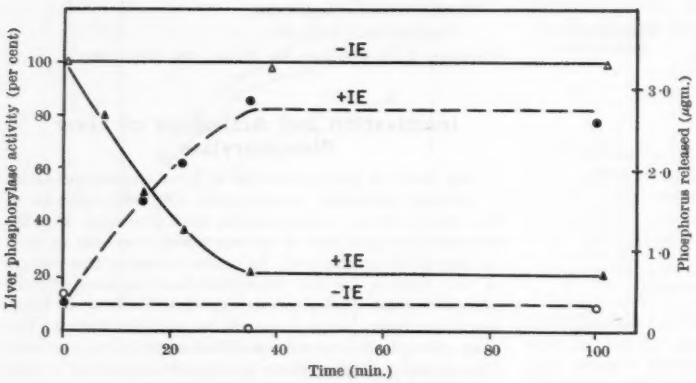

Fig. 1

Recent experiments with liver slices have indicated a rapid incorporation of radioactive phosphate into liver phosphorylase. Radioactive liver phosphorylase was prepared by incubating liver slices aerobically or anaerobically in the presence of radioactive phosphate and was afterwards purified about 400-fold on a protein basis. The incorporated radioactivity was not released when the liver phosphorylase was precipitated with cold trichloroacetic acid, but the radioactivity was released into the trichloroacetic acid supernatant after enzymatic inactivation of liver phosphorylase with the inactivating enzyme. In a single preliminary experiment the effect of epinephrine on the incorporation of radioactive phosphate has been investigated. The addition of epinephrine to slices after incubation for 30 min. increased the amount of active liver phosphorylase within 10 min. to a level well above that of the control without epinephrine; this was paralleled by an increased incorporation of radioactive phosphate into liver phosphorylase.

In summary, phosphate is liberated from purified liver phosphorylase as it is inactivated enzymatically; radioactive phosphate is incorporated into the phosphorylase of liver slices. These experiments with slices suggest that the observed enzymatic release of phosphate from purified liver phosphorylase is related to a physiological mechanism concerned with the activation and inactivation of liver phosphorylase in intact cells.

This work was supported in part by grants from the National Science Foundation and Eli Lilly and Co.

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A New Amino-Acid from Apples

In an earlier paper[1], two unidentified amino-acids in apples were reported. Of these, one (*A*) has now been isolated and shown to have the empirical formula $C_6H_{11}NO_3$. It is tentatively suggested that the substance is 4-hydroxy-methylproline.

The substance was extracted with 75 per cent ethanol from 880 lb. of Granny Smith and Delicious apple tree prunings which were dormant, without expanded leaves. Purification and separation were carried out with resins ('Zeo-Karb 215' and '225') and a cellulose powder column. The unknown was obtained as a hydrochloride, converted to the free base by displacement from 'Zeo-Karb 225' with *N* ammonium hydroxide and was crystallized from a saturated hot aqueous solution to give white microcrystals. (Found: C, 49·41; H, 7·65; N, 9·85; O, 33·2. Calc. for $C_6H_{11}NO_3$: C, 49·64; H, 7·64; N, 9·65; O, 33·07 per cent.)

A final yield of 0·08 gm. was obtained (quantitative recovery was not attempted). The substance is readily soluble in cold water, insoluble in absolute ethanol and melts with decomposition at about 250° C. The unknown gives a yellow colour with ninhydrin and a blue colour with isatin, similar to the colours given by proline. The isatin spot does not turn red on being sprayed with Ehrlich's reagent[2]. The hydrochloride of the unknown is soluble in water, and in absolute methanol, ethanol and propanol. It is insoluble in acetone and ether, which precipitate it from solution as an oil.

The analysis, assuming 1 atom of nitrogen, could fit a hydroxy-methylproline or a hydroxy piperidine derivative; but the colour reactions with ninhydrin and isatin and the general chromatographic behaviour (on paper and ion exchange columns) favours the former possibility. General evidence consistent with this interpretation is: (1) secondary nitrogen was indicated by (*a*) positive test with Feigl's reagent[3], and (*b*) the unknown being recovered unchanged after hydrolysis of the compound formed by reaction with nitrous acid:

$$\rangle NH + HNO_2 \rightarrow \rangle N{-}NO \xrightarrow[H_2O]{HCl} \rangle NH.$$

(2) a Kuhn–Roth C—CH_3 test was negative.

The suggested structure requires further verification. The infra-red spectrum of the unknown is now being examined by other officers of this Division and 4-hydroxy-methylproline is being synthesized by the Department of Organic Chemistry, University of Sydney.

I am indebted to officers of the Victorian Department of Agriculture for providing the prunings, and to the following members of the Commonwealth Scientific and Industrial Research Organization: Mr. P. Hunter, Division of Industrial Chemistry, for carrying out the large-scale extraction; Dr. W. Zimmerman, Division of Industrial Chemistry, for the micro-analysis; Miss M. V. Haas, for technical assistance; and Dr. J. R. Price, Division of

Industrial Chemistry, and Dr. H. S. McKee, Plant Physiology Unit, for helpful advice. [See also Hulme, A. C., *Nature*, December 4, p. 1055 (1954).]

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Infra-red Spectra of the New Proline Derivative from the Apple

In the work of McKee[1] and of Hulme[2] on apple, two substances have been isolated. One of these, from apple peel[2], has been referred to as proline substituted, probably on the same carbon, with methyl and hydroxyl groups. The other, from apple twigs, has been referred to by McKee[1] and described above by Urbach as 4-hydroxy-methyl proline, that is, the hydroxyl group is on the methyl side-chain.

Samples of the original materials isolated by these authors became available in this laboratory. They were therefore subjected to infra-red analysis using the potassium bromide disk method. The resulting spectrograms are shown in Fig. 1. This evidence clearly establishes the identity of the two substances.

The isomeric hydroxy-piperidine carboxylic acid was also available in this laboratory and was submitted to infra-red analysis at the same time. The resulting spectra were quite different. This evidence confirms the pyrrolidine, rather than the piperidine, structure for the new amino-acid from apple.

The following interpretations of the infra-red spectra can be made, and we have confirmed these in consultation with workers familiar with the analysis of infra-red spectra: (1) The band at 5·9 microns (frequency 1,600–1,560 cm.$^{-1}$) is characteristic of the ionized carboxyl group of amino-acids (ref. 3, p. 206). (2) The band at 6·1 microns (frequency 3,400–3,200 cm.$^{-1}$) occurs in proline (ref. 3, p. 208). (3) The band at 3·1 microns (frequency 3,400–3,200 cm.$^{-1}$) is characteristic of an imine (ref. 3, p. 213).

To this point the evidence, though consistent with the substance being a proline substituted with both methyl and hydroxyl groups, does not distinguish between the alternative structures suggested by Hulme and by Urbach. While the analysis of these curves, following Bellamy[3], may seem to favour the tentative conclusion of a hydroxyl linked directly to carbon in the ring, it is obvious that a decision awaits other evidence, such as that of synthesis and comparison of infra-red curves for other model compounds.

The observations reported above were made possible through the Grasselli Grant to Cornell University for work being directed by one of us (F. C. S.).

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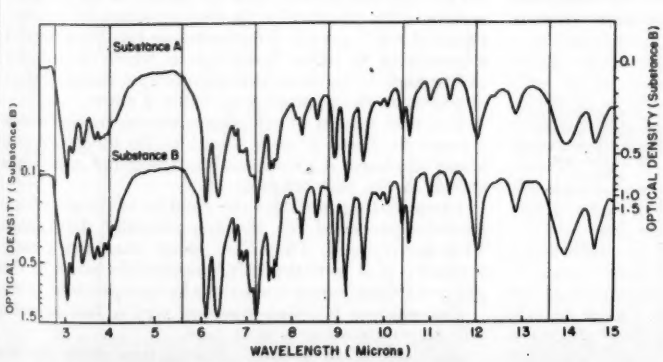

Fig. 1. The infra-red spectra of samples of an amino-acid obtained from the peel of apples by Hulme (substance *A*) and from apple twigs by Urbach (substance *B*)

Consideration of the Vi-phage Types of *Salmonella typhi* on a Structural Basis

RECENTLY published work[1a,b,c] has indicated that many of the Vi-types of the typhoid bacillus owe their characteristic reactions with the adapted preparations of Vi-phage II [2] to the carriage of temperate non-Vi phages which have been called type-determining phages. The symbols assigned to these type-determining phages are small letters corresponding to the capitals by which the related Vi-types are designated, or a number with a superscript prime sign when the corresponding Vi-type has a numerical symbol. Thus, Type D_1 carries phage d_1 and Type D_6, phage d_6; Type 25 carries phage 25′; and so on. Some types carry phages indistinguishable from those carried by other types, in which case the phages are designated by the same symbol. For example, Type 33 carries a phage apparently identical with that carried by Type D_6, and the determining phage of both types is therefore called phage d_6. A complete list of the lysogenically determined types identified hitherto is given in Table 1.

All the Vi-typing phages are derived from Vi-phage II, and the great majority have been prepared by propagation of phage *A* on the respective Vi-types of *Salm. typhi*. According to the convention originated by Craigie and Yen[3], the various Vi-types and the homologous adapted typing preparations of Vi-phage II are designated by identical symbols. It has been shown[3] that the specific adaptations of Vi-phage II

to the various types can be divided into two groups: those which are modified in phenotype only and revert to phage *A* when propagated on Type *A*; and those which present the characters of genotypic or host-range mutants, this being a permanent change conditioned by the Vi-types on which they have been grown. Members of the latter group retain the power to attack the types on which they have been propagated whatever subsequent phenotypic adaptations they may undergo. The broad rule has been established that the non-lysogenic types of *Salm. typhi* impose only a phenotypic change on Vi-phage II, whereas the lysogenic types produce a genotypic alteration. There are, however, several exceptions to this rule.

The artificial replication of naturally occurring Vi-types can be effected by lysogenizing non-lysogenic types with type-determining phages[1a,b,c]. For example, Type F_2, which carries phage f_2, can be made by lysogenizing Type F_1 with phage f_2. These artificially prepared types are indistinguishable from those occurring naturally. It has recently been found convenient to consider the lysogenically determined Vi-types in terms of the complex: non-lysogenic type plus type-determining phage. Thus, using the example given above, Type F_2 would be designated $F_1(f_2)$, where the symbol in parentheses indicates the phage carried. Such a nomenclature gives a structural formula which shows the phylogenetic relationships of the Vi-types concerned. The types of *Salm. typhi* that will be lysed by an adapted phage can be predicted from the structural formula of the type on which the adaptation has been carried out. For example, Type 33 = $C(d_6)$. Phage d_6 is the determining phage carried by Type D_6, which is structurally $A(d_6)$. Vi-phage II adapted to $C(d_6)$ acquires simultaneously the lytic range of phage *C* plus that of phage D_6. Therefore, an adaptation to $C(d_6)$ will be able to lyse Type *A* (which is sensitive to all adaptations of Vi-phage II), Type *C*, and also any lysogenic types derived from these two non-lysogenic precursors by acquisition of phage d_6 or a phage closely related to it. Phages f_2 and 30′ are closely related to d_6 (see Anderson and Felix, ref. 1c). The additional types lysed by phage 33 are therefore: $D_6(=A(d_6))$, $29(=A(f_2))$, $30(=C(30')$ or $C(f_2))$ and, of course, Type $33(=C(d_6))$ on which the phage was grown. It should be noted that, although phages f_2 and 30′ will not endow a cell with resistance to Vi-phage II adapted to types carrying phage d_6, the converse does not hold. Carriage of phage d_6 confers relative or complete resistance to Vi-phage II adapted to strains carrying phages f_2 or 30′.

Table 1

Original designation of Vi-type	Type-determining phage carried	Structural formula of Vi-type	Types fully lysed by homologous adaptation of Vi-phage II in routine test dilution
D_1	d_1	$A(d_1)$	*A*, D_1
D_4	d_4	?(d_4)*	*A*, D_1, D_4
D_6	d_6	$A(d_6)$	*A*, D_6, 29
F_2	f_2	$F_1(f_2)$	*A*, F_1, F_2, 29
T	*t*	$A(t)$	*A*, *T*
25	25′	$A(25')$	*A*, 25
26	26′	$A(26')$	*A*, 26
29	f_2 or 29′	$A(f_2)$ or $A(29')$†	*A*, 29
30	f_2 or 30′	$C(f_2)$ or $C(30')$†	*A*, *C*, 29, 30
31	26′	$E_1(26')$	*A*, E_1, 26
33	d_6	$C(d_6)$	*A*, *C*, D_6, 29, 30, 33

* The non-lysogenic precursor of Type D_4 is at present unknown.
† Phages d_6, f_2, 29′ and 30′ belong to a single group.

Table 2

Starting phage	Structural formula of lysogenic type on which the starting phage was grown	Non-lysogenic type on which starting phage is propagated	Predicted type of resulting phage	Structural formula of type to which new phage corresponds
F_2	$F_1(f_2)$	*A*	29	$A(f_2)$ = Type 29
F_2	$F_1(f_2)$	*C*	30	$C(f_2)$ = Type 30
29	$A(f_2)$	*C*	30	$C(f_2)$ = Type 30
30	$C(f_2)$	*A*	29	$A(f_2)$ = Type 29
D_6	$A(d_6)$	*C*	33	$C(d_6)$ = Type 33
33	$C(d_6)$	*A*	D_6	$A(d_6)$ = Type D_6
26	$A(26')$	E_1	31	$E_1(26')$ = Type 31
31	$E_1(26')$	*A*	26	$A(26')$ = Type 26

Table 1 shows the application of the structural formulæ to the known lysogenically determined types.

A lysogenically determined type will not be sensitive to Vi-phage II adapted to another type carrying the same or a similar determining phage, unless its non-lysogenic precursor is the same as that of the other type (for example, Type *C* is the common precursor of Types 30 and 33 in the illustration given earlier) or is the universally sensitive Type *A*. Thus Type F_2, which has the structural formula $F_1(f_2)$, is resistant to phages 29 and 30—both adapted to types carrying phage f_2—because the non-lysogenic precursors of Types 29 and 30 (*A* and *C* respectively, see Table 1) cannot modify Vi-phage II so that it will lyse Type F_1. Thus, the difference between Vi-phage II adapted to Types F_2, 29 and 30 is the same as the difference between this phage adapted to Types F_1, *A* and *C* respectively, and neither phage *A* nor phage *C* will lyse Type F_1.

When Vi-phage II has been grown on a lysogenic type that imposes a permanent change on it, the phenotypically modifiable portion of the phage shows an unimpaired ability to alter its host-range according to the non-lysogenic types on which it is afterwards grown. It thus seemed probable that, in superimposing a phenotypic modification on a genotypically altered phage by growing the latter on selected non-lysogenic types, phages might be produced which would lyse lysogenic types possessing a suitable structural formula. Phage D_6 is prepared by growing phage *A* on Type D_6; this type is structurally $A(d_6)$. As phage D_6 will not lose the specificity imposed on it by the portion of the cell carrying phage d_6, propagation on Type *C* should produce a phage corresponding to the lysogenic host-cell complex $C(d_6)$ which is Type 33 (see Table 1). This has been confirmed experimentally, and the phage 33 so produced is apparently identical with that obtained by growing phage *A* on Type 33. This principle has been applied successfully to other instances in which adaptation of Vi-phage II involves both phenotypic and genotypic changes, as the examples in Table 2 show.

The host ranges of all phages shown in the fourth column in Table 2 were found to be identical with those of phage *A* grown on the lysogenic complexes shown in the last column.

These findings indicate the validity of the structural formulæ proposed for the lysogenically determined Vi-phage types. They also show that the phenotypically and genotypically modifiable sites in Vi-phage II function as operationally independent units.

The subject is being pursued and a full account will be published at a later date.

Note added in proof. Fluctuation tests of the Luria–Delbrück type recently carried out suggest that the genotypically changed phages are selected

host-range mutants that pre-exist in concentrated preparations of phage *A*.

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Effect of Aeration on the Formation of Nitrate-reducing Enzymes by *Ps. aeruginosa*

Skerman[1], using a recording polarograph, reported that an actively growing culture of *Pseudomonas* was saturated with oxygen only when the broth was agitated by a stirrer revolving at 500 r.p.m., and that under such conditions nitrate was not reduced. In cultures stirred at 100, 200 or 300 r.p.m., there was a rapid drop in the oxygen tension and nitrate was then reduced.

Experiments carried out in this laboratory, using suspensions of *Ps. aeruginosa* N.C.T.C. 6750 grown in 0·2 per cent nitrate broth and aerated by continuous shaking, suggested that aerobic denitrification occurred in some of the cultures. The inability of most of the shaken cultures to reduce nitrate anaerobically when tested in Warburg manometers suggested that oxygen was inhibiting the formation of nitrate-reducing enzymes, the occasionally active suspension being presumably due to incomplete aeration. The only obvious variables to account for the occasionally active cultures were differences in the size and shape of the flasks used. Therefore an experiment was carried out to determine the effect of altering the size and shape of flask on the denitrifying activity of the suspension. Six different flasks (Fig. 1, 1–6) were used.

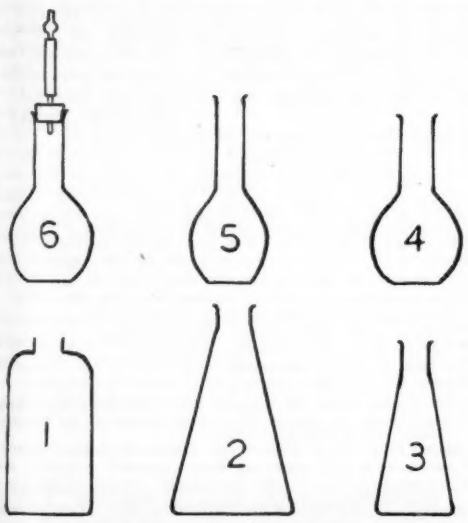

Fig. 1. 1, One-litre bottle used for intravenous glucose administration. 2, One-litre Erlenmeyer flask. 3, 500-ml. Erlenmeyer flask. 4, 500-ml. Florence flask. 5, 490-ml. Florence flask. 6, 500-ml. Florence flask fitted with a tight-fitting rubber bung, tubing and clip for replacing the air with nitrogen

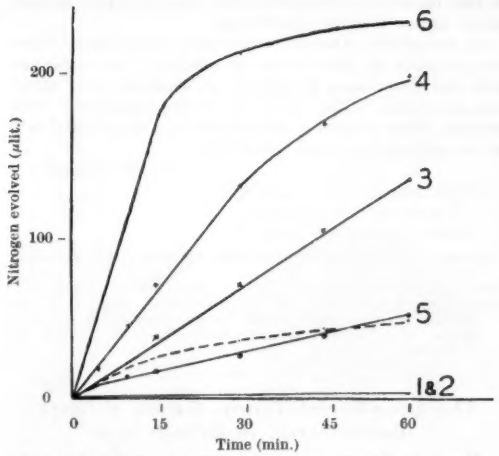

Fig. 2. Evolution of gaseous nitrogen by suspensions 1–6 under anaerobic conditions. The broken line represents endogenous gas evolved by suspension 6

Each flask, containing 200 ml. nitrate broth, was inoculated and shaken at 37° C. for 16 hr. The growth was washed twice with saline and resuspended in *M*/15 phosphate buffer, *p*H 7·4, and standardized turbidimetrically. The suspensions numbered 1–6 were tested for nitrogen evolution in Warburg manometers using 0·1 ml. of *M*/5 sodium nitrate as the source of oxygen and yeast autolysate as the hydrogen donor[2]. The air was replaced by oxygen-free nitrogen, a small stick of yellow phosphorus being included in each cup to remove all traces of oxygen.

Suspension 6 reduced the nitrate quantitatively to nitrogen gas in about 15 min. at the rate of 58 μl./hr./mgm. of wet-weight of cells. Suspensions 1 and 2 showed no denitrifying activity and the rates for suspensions 3, 4 and 5 were 11, 15 and 4·5 μl. nitrogen/hr./mgm. of wet-weight of cells respectively. The gas evolution by the last three suspensions showed that aeration of flasks 3, 4 and 5 was insufficient to prevent the formation of nitrate-reducing enzymes, although the suspensions showed a much lower activity than the anaerobic control. Aeration of the cultures in flasks 1 and 2 was enough completely to inhibit the formation of the nitrate-reducing enzymes. The larger volume of air and the more violent agitation of the broth in flasks 1 and 2 resulted in more efficient aeration of the cultures compared with those in flasks 3, 4 and 5. Hence the efficiency of aeration of the culture determined the ability of the suspension to reduce nitrate to gaseous nitrogen when tested under anaerobic conditions.

This work indicates that reports of aerobic denitrification by various workers[3] using shallow layers of undisturbed media and also deeper layers aerated by bubbling air through the medium may well be due to failure to meet the high oxygen demand of a rapidly multiplying aerobic organism in a liquid medium. Many methods of forced aeration in deep cultures were insufficient to maintain oxygen saturation, especially as the growth became denser, and

it was then that denitrification was detected, apparently under aerobic conditions.

In addition to the size and shape of the flask, other factors such as the volume of medium, the organism and the speed and amplitude of shaking may affect the aeration. The work is being continued with several other strains of denitrifier and the results will be described in detail elsewhere.

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The Long-finned Tunny, *Germo alalunga* (Bonnaterre), in British Seas

Mr. S. S. Pickard has kindly supplied details and a photograph of a long-finned tunny, albacore or germon, *Germo alalunga* (Bonnaterre), found alive in a shallow pool at low tide at Morecambe, Lancs, on August 14, 1954. The fish measured 32 in. from snout to caudal fork, had a pectoral fin 12 in. in length and weighed 22 lb. This is only the twelfth British record of the species, the other eleven being as follows, the numbers indicating the footnote references 1–11: (1) "Several years" prior to 1846 (Mount's Bay, Cornwall); (2) summer of 1846 (Mount's Bay, Cornwall); (3) March 13, 1861 (Chesil Beach, Weymouth, Dorset); (4) August 26, 1865 (mouth of River Exe, Devonshire); (5) October 25, 1897 (Silloth, Solway Firth); (6) June 1900 (off the Orkney Is.); (7) autumn 1901 (coast of Wexford); (8) August 1914 (Dugort, Achill Island, Co. Mayo); (9) November 1932 (Lochgoilhead, Firth of Clyde); (10) June 20, 1934 (Kilmun, Holy Loch, Firth of Clyde); (11) September 16, 1947 (west of Dingle, Co. Kerry).

Germo alalunga is essentially a warm-water species, ranging widely through the Atlantic from Massachusetts to the West Indies and from the Orkneys to the Cape of Good Hope, and entering the western Mediterranean. Off Spain, in the Bay of Biscay and towards the approaches of south-west Ireland, there is a considerable fishery for it; but Moreau[12] gives the Bay of Morlaix as the eastern limit along the Breton coast and states that the germon is extremely rare in the Channel beyond there. Saemundsson[13] gives no records for Iceland, nor Smitt[14] nor Andersson[15] for Scandinavia. A solitary 'record' for Holland ascribed to van Bemmelen[16] by several authors proves to be unfounded: van Bemmelen writes generally of unidentified tunny in the North Sea and mentions two European species, but with no positive identification or presumption of *G. alalunga* in Dutch waters.

Fig. 1. Long-finned tunny, stranded at Morecambe on August 14, 1954

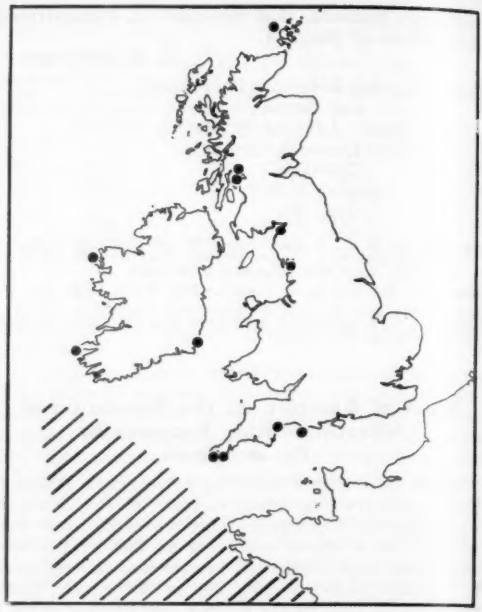

Fig. 2. Distribution of *Germo alalunga* in British waters. The cross-hatched area shows the approximate northern limits of the French germon fishery

This, then, is a fish which is near the northern limits of its range in British seas, and its occurrence is of interest in relation to modern studies[17] on the effects of climatic fluctuations on the distribution of northern faunas. The excellent work on the food of the germon by Legendre[18] and by Bouxin and Legendre[19] will serve equally well as an introduction to its general biology and to relevant literature.

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Triploid Nauplii of *Calanus finmarchicus*

WHILE examining the chromosomes of developing eggs of *Calanus finmarchicus*, it was noticed that on two occasions a proportion of the eggs of a clutch were triploid with 51 chromosomes, the haploid number being 17. It has been observed also that clutches of eggs of *Calanus finmarchicus* are occasionally seen in which one (rarely more) of the eggs is much larger than sister eggs of normal size. In order to find out whether these large eggs are triploid, one just about to undergo the fourth cleavage was fixed in acetic alcohol immediately the nuclear membranes disappeared, and a squash was made with aceto-carmine. The chromosomes were rather faintly stained; but in one of the divisions, as shown in Fig. 1, 102 chromosomes could be counted in anaphase, 51 on each side.

Most of the outsize eggs developed with their smaller fellows up to about the gastrula stage quite normally, but as a rule they did not hatch with the rest and died later. Up to at least the anaphase of the third cleavage, however, the triploids divided synchronously with their diploid sisters. On a very few occasions the large eggs have actually hatched into nauplii correspondingly large in size. One of these appeared to be quite normal except for its gigantism, but in an attempt to rear it further this specimen was lost. A second specimen which hatched (Fig. 4) was a monster with an abnormal first antenna and the second antenna and mandible united on one side. A normal nauplius is shown in Fig. 5 drawn to the same scale for comparison.

There are several ways in which a triploid embryo may arise; but most of them are ruled out here. That large size is often associated with a polyploidy is well known; but in this example the large size of the egg at the time it is laid indicates that the polyploidy must have arisen earlier than the time of laying. A normal egg is laid when the chromosomes are arranged on the metaphase plate of the first maturation division, 17 bivalents, in the form of rings, being clearly discernible (Fig. 2). It is not until several minutes after the egg is laid that the first polar body is produced (Fig. 3). If polyploidy were due to the union of a haploid ovum with a diploid sperm, or with two haploid sperms, this event would take place too late to account for the large size, and it seems unlikely that the large size would be responsible for polyspermy. One possibility which remains is that the triploid has resulted from the union of a normal, haploid sperm with a diploid egg-cell. The most usual way for diploid egg-cells to arise is by failure of reduction at meiosis; but again this would take place too late to affect the size of the egg. A diploid egg could arise by reduction from a tetraploid oocyte, the tetraploid condition resulting from the division of the chromosomes of one of the oogonia without a corresponding division of the nucleus. This, if it occurred sufficiently early, would account not only for the large size of the eggs, but also for the fact that these do not always occur singly in a clutch of eggs. On this hypothesis we might expect to find 1, 2, 4, 8 or some other power of 2 such eggs in a clutch. From one of the two clutches of eggs in which triploidy was first observed a sample of nineteen eggs was examined cytologically; of these eleven were diploid, four were triploid and four uncountable. From the other abnormal clutch sixteen were examined, two being diploid, two triploid and the rest uncountable. Unfortunately, the sizes of these eggs were not noted. On the rare occasions when large eggs have been noticed, they have usually occurred singly. Once there were four larger than the rest; but three of them were smaller than those usually distinguished as 'large'. This hypothesis might also account for the poor viability of the embryos, for with four identical chromosomes of each of the seventeen types, a regular reduction division to 34 bivalents would be a rare occurrence, as tetravalents and trivalents would be formed as well as bivalents. However, on all occasions on which accurate counts have been made of the anaphase chromosomes of a dividing triploid cell, precisely 51 chromosomes have been counted on each side.

Alternatively, the large egg may be a binucleate one, each nucleus undergoing a normal meiosis in which only bivalents would be formed. A triploid embryo would then result from the fusion of the two haploid egg nuclei with one sperm nucleus.

It might be possible to distinguish between these hypotheses if a large egg could be examined at the stage corresponding to Fig. 2; but these eggs are so rare that we have not yet found one sufficiently soon after it was laid to be able to do this.

J. P. HARDING
British Museum (Natural History),
London, S.W.7.

S. M. MARSHALL
Marine Station, Millport. Oct. 14.

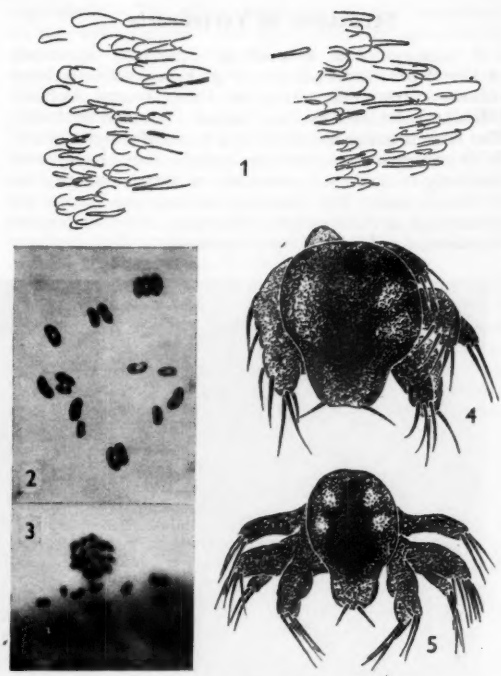

Fig. 1. Fourth cleavage of triploid nauplius showing 51 chromosomes on each side at anaphase. × 530

Fig. 2. Metaphase I from a normal egg immediately after laying, showing 17 bivalents. × 670

Fig. 3. First polar body formation, 5 min. after the egg was laid. × 670

Fig. 4. Triploid nauplius soon after hatching. × 120

Fig. 5. Normal nauplius. × 120

All figures from preparations preserved in the British Museum (Natural History)

Structure of *Vertebraria*

A REMARKABLE completely fusinized specimen of *Vertebraria indica* Royle (Fig. 1) has recently been collected from the south of Jhagrakhand Colliery (Middle Permian) in the Central Province of India. The rock bearing the fossil is a piece of greyish shale. It shows the characteristic rectangular blocks with two longitudinal and a number of transverse grooves of *Vertebraria*. The fusinized rectangular blocks are sometimes as thick as $\frac{1}{2}$ in. This type of well-organized fusinized fossil is not very common.

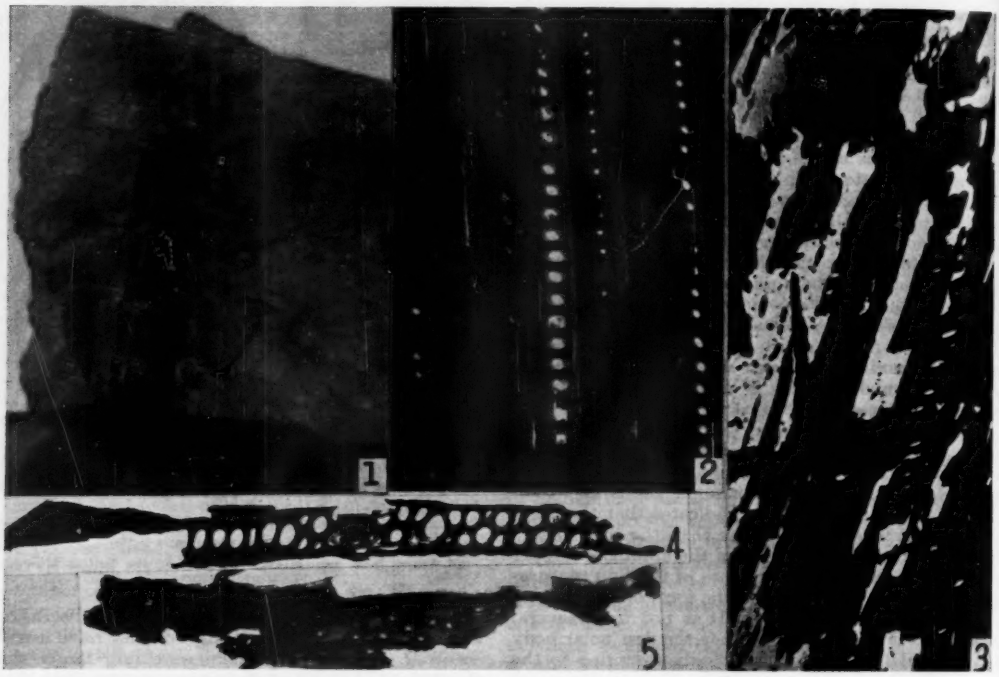

Fig. 1. Part of a shale showing a fusinized axis of *Vertebraria indica*, slightly less than natural size
Fig. 2. Maceration residue from one of the flat fusinized rectangular blocks of the axis shown in Fig. 1, showing tracheids of the secondary wood with uniseriate pitting. × 300
Fig. 3. Part of a cellulose-pull showing a number of tracheids with variously formed pit-closing membranes. × 300
Fig. 4. Maceration residue showing a tracheid with uni- to bi-seriate pitting of different shapes and sizes. × 300
Fig. 5. Maceration residue showing a tracheid with irregular pitting. × 300

All attempts to bring out the nature of the primary wood by getting suitable transverse sections of the fusain failed. Only the secondary wood could be profitably examined by preparing cellulose peel and maceration residues.

Since the structure of the secondary wood of *Vertebraria* has been excellently described by Walton and Wilson[1], only points of additional interest have been noted here. The tracheids vary considerably in breadth (15·5–40 μ), with one to three series of bordered pits on the radial walls. The pits are closely or slightly contiguous, rarely separated, and sometimes a few are abruptly isolated; they may be circular but are more often elliptical, and the size ranges from almost pinhole-like to quite large and well-formed pits (Figs. 2–3). In some tracheids there are regular closing membranes which may partially or wholly close the pit orifices (Fig. 3). The characteristic elliptical or slit-like pit orifices, when present, are due to the membranes closing in from either side of the pits (Fig. 2). The same tracheid may often bear uni- and regularly or irregularly bi-seriate pits of widely different shapes and sizes (Fig. 4). Sometimes the pits are all irregularly arranged (Fig. 5). Such features are often clearly visible and as such cannot be due to poor preservation. It appears that some of these tracheids are exhibiting transition stages between the scalariform and pitting[2]. The general impression is that the irregular organization of some of the tracheids is of primitive nature.

The entire thickly fusinized rectangular blocks yielded closely knit masses of tracheids often in association with small rays one to two cells high. The previous interpretation that "the rectangular areas represent the large medullary rays and the longitudinal and transverse grooves or ridges the secondary wood" only[1], therefore, needs careful re-examination.

It is expected that the examination of other similar specimens (now being sought) from the Sohagpur Coalfield may reveal the general nature of the anatomical organization, especially of the primary wood, in *Vertebraria*. This is obviously important for our knowledge of the *Glossopteris* flora.

I wish to thank Mr. S. K. Ghosh, geologist in the Sohagpur Coalfield, for the material.

J. SEN

Botanical Laboratory,
University College of Science,
Calcutta 19. Oct. 1.

[1] Walton, J., and Wilson, J. A. R., *Proc. Roy. Soc. Edin.*, **52**, 202 (1932).
[2] Sen, J., *Bull. Bot. Soc. Bengal.*, **2**, 97 (1948).

Presence of Nucleus and Cytoplasm in the Mature Vessel Elements and Fibre Tracheids in Japan Jute Plants

It is commonly held that the mature vessel elements of plants are non-living cells. In jute[1], the cell-wall of the vessel elements is lignified and has scalariform thickening and simple pits on the lateral walls. Esau has stated: "In the mature state, tracheids and vessel members are more or less elongated cells with lignified secondary walls and devoid of protoplasts". In a recent publication[2], she mentions (p. 225): "After the secondary walls are fully formed and lignified the swollen parts of the primary wall break down (fig. 11.3,*F* and plate 25,*D*) and finally the protoplasts die and disappear". The course of events is interpreted by Shah[3] in the following way: "The disappearance and loss of the protoplast usually synchronizes with the formation of perforation plates (Eames and MacDaniels, fig. 49; Esau, figs. 11–13)". Recently, I have described[4] how, during the course of development of primary vessel elements, "the protoplasts disappear after the deposition of the secondary thickening matter".

In a recent investigation of the stem of jute plants grown in East Bengal, nucleus and cytoplasm were found in the mature vessel elements and fibre tracheids of the secondary xylem (Figs. 1–3). Nucleus and cytoplasm were not observed in the vessels of all the varieties of jute plants but only and rarely in the variety Japan of the species *Corchorus capsularis*. The fibre tracheids in the secondary xylem with nucleus and cytoplasm are abundantly present in the varieties Fanduk and Japan of this species. The nucleated vessel elements are considerably elongated cells having lignified walls, simple perforations and simple pits in the lateral walls. The nucleus with a single nucleolus is prominent and lies embedded in a small amount of cytoplasm. The cytoplasm is granular and vacuolated. In the fibre tracheids both the nucleus and cytoplasm are very prominent. The prominent cytoplasm in some fibre tracheids is found to extend more than half the length of each tracheid (Figs. 2 and 3).

This condition was first reported by Shah[3], who examined the macerated materials of the tendrils of *Vitis repens* growing in Surat. I have also examined the macerated materials of the stems of jute plants.

The finding of nucleus and cytoplasm in the mature vessel elements, as well as in the fibre tracheids, is contrary to the observations of Esau and of Eames and MacDaniels.

A. J. Mia

Jute Research Institute,
Tejgaon, Dacca.
Aug. 29.

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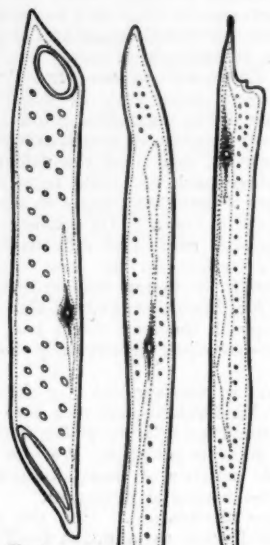

Fig. 1. A vessel segment with a single perforation showing nucleus and cytoplasm. × 550

Figs. 2 and 3. Fibre tracheids of secondary xylem with prominent nucleus and cytoplasm. × 550

Revision of Supposed Jurassic Angiosperms from New Zealand

In Arber[1], Laurent identified two angiosperms, *Artocarpidium arberi* Laurent and *Phyllites* sp., on a slab of matrix from a large collection from Waikato Heads; Arber[1] also identified *Cladophlebis australis* (Morris) in the same slab and suggested a Neocomian age for the whole collection. In spite of intensive collecting at Waikato Heads, no further angiosperms have been found, and Edwards[2] doubted whether the slab came from Waikato Heads. He concluded that the rest of the Waikato Heads flora is Upper Jurassic. Evidence is presented here in support of Edwards's suggestion that the slab did not come from Waikato Heads; and further that it came from Upper Cretaceous (about Maestrichtian) coal measures of Pakawau, South Island. The age of the remaining plant fossils truly from Waikato Heads is not precisely known. Dr. C. A. Fleming (New Zealand Geological Survey) has told me that the underlying marine beds are probably Neocomian.

The two angiosperms resemble specimens from Pakawau. *Artocarpidium arberi* resembles *Fagus producta* Ettingshausen[3], and *Phyllites* sp. resembles an undescribed species from Pakawau. The fern-like plant on the slab identified as *Cladophlebis australis* by Arber[1] (Pl. IV, Fig. 1; Pl. XIV) and one cycad cannot be matched in other material from Waikato Heads. It is really *Blechnum priscum* Ettingshausen[3], described from Pakawau, and not known from older rocks. In addition, I have identified a cycad on the slab as *Taeniopteris stipulata* Hector[4], a species founded on specimens from Pakawau and unknown from pre-Turonian beds in New Zealand. *T. stipulata* was not recorded by Arber.

Moreover, the specimen of Arber's "*Cladophlebis australis*" (Arber[1], Pl. IV, Fig. 1) is also the original

of a figure on an unpublished plate, prepared by Hector, in a series labelled "Pakawau" in his handwriting.

The cause of the error may lie in the numbering of the specimens; specimens from Pakawau are registered with the New Zealand Geological Survey locality number 409 (collected by the Geological Survey in 1866), and those from Waikato Heads bear the number 410 (collected by the Geological Survey in 1868). Apparently, a slab from the Pakawau collection was wrongly numbered and placed in the Waikato Heads collection.

The earliest New Zealand angiosperms known at present are those from beds in the Middle Clarence Valley, which on the evidence of plant microfossils are Turonian in age.

D. R. McQueen

New Zealand Geological Survey,
156 The Terrace,
Wellington, New Zealand.
Sept. 22.

[1] Arber, E. A. N., *N.Z. Geol. Surv. Pal. Bull.*, **6**, 62 (1917).
[2] Edwards, W. N., *Ann. Mag. Nat. Hist.*, (10), **13**, 86, 87 (1934).
[3] Ettingshausen, C. v., *Trans. N.Z. Inst.*, **23**, 237 *et seq.* (1891).
[4] Hector, J., Det. Cat. Ind. Col. Exhib. (London), Fig. 24A, 3, N.Z. Geol. Survey, Wellington (1886).

A Seed-borne Nematode Infestation in Annual Asters

Aphelenchoides ritzema-bosi has a wide host-range but is most frequently recorded as a pest of chrysanthemums. In this plant, infestations usually start at the base of the stem and work upwards in the direction of the flower head. In severe attacks, most of the leaf area is killed, and the flower head itself may become infested. Chrysanthemums are normally propagated vegetatively, and hence seed-borne infestation is unlikely to occur. However, some hosts of *A. ritzema-bosi* are grown from seed, and the object of this communication is to record seed-borne infestation in the annual aster (*Callistephus chinensis*).

In early May 1954, severe injury was noted on aster plants being grown in sterilized compost in seed boxes on a nursery in Suffolk. These plants were found to be heavily infested with *A. ritzema-bosi*, living mainly ectoparasitically in the leaf axils. Fortunately a supply of the original seed was available for examination. 14 gm. of seed was placed in a Baermann funnel and more than three hundred nematodes were extracted. Small pieces of leaf and sepal debris were present mixed with the seed, and nematodes emerged in large numbers from this debris and also from seed from which the debris had been removed. It therefore seems probable that the species was living both ecto- and endo-parasitically in the flower head, and that a proportion of the nematodes was attached to or in close association with the seed coat. Identical symptoms were reproduced in the laboratory on aster plants raised from this seed in sterilized compost.

Seed-borne infestation in the genus *Aphelenchoides* has not hitherto been recorded. A full account of this occurrence and of the symptoms on the aster plants will be published elsewhere.

E. B. Brown

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Anstey Hall,
Trumpington, Cambridge.
Oct. 7.

The Genetic Component of Language

R. W. Thompson, in discussing the genetic component of language[1], complains that Darlington and Mather, in an introduction to genetics[2], "have simplified the issue". This is true, and one of the complications Mr. Thompson introduces is highly appropriate. But in my original paper I had considered it[3].

In this paper I tried to explain certain principles.

(1) That the three threads by which continuity and change may be followed in language, namely, grammar, etymology and phonetics, are in a long-term sense independent.

(2) That only on the phonetic side do we expect or find a serious genetic component.

(3) That the genetic preference of the group rather than the genetic capacity of the individual is what determines phonetic evolution.

Among the instances I gave of the working of these principles was the one quoted by Mr. Thompson, namely, the intrusion of the dental fricative along different lines, at different times and in different parts of the Spanish-speaking world, an instance which might be elaborated from the study of Latin American dialects.

Mr. Thompson suggests that the theory of a genetic component of language was regarded as speculative by Darlington and Mather. It is speculative in the sense that it is a beginning rather than an end of investigation. It opens new ground for research in phonetics, linguistics, anatomy and psychology, and ultimately in the general understanding of human society. What we have to do is to apply non-genetic ideas and techniques in relation to the genetics of individuals and of populations.

I may give an example of each.

(1) Mr. Thompson agrees that "the speech organs of various races vary in shape". But he maintains that these variations could have no influence on the production of speech except on timbre. Are we to suppose, then, that the defects of speech which may distinguish one child from his brothers and sisters never have any basis in the shapes of nerves, muscles or bones? Or conversely, that the established genetic control of differences in tongue control has no effect on the ease of pronouncing various sounds? I do not believe either of these corollaries of Mr. Thompson's view. But the anatomist and the speech therapist could test their truth, and their observations would help to solve our problem.

(2) We have to discover just how the community, its classes and individuals, interact over long spaces of time in small and large, stable and changing, literate and illiterate societies. We now understand enough of the genetics of these situations to relate them with the historical evidence[4].

Such is the speculation. But the principle of genetic determination in language itself is far from speculative. Those who now object will be telling us soon enough that it is little more than a truism.

C. D. Darlington

Botany Department,
Oxford.
Dec. 16.

[1] Thompson, R. W., *Nature*, **174**, 1095 (1954).
[2] Darlington, C. D., and Mather, K., "The Elements of Genetics" (Allen and Unwin, London, 1949).
[3] Darlington, C. D., *Heredity*, **1**, 269 (1947).
[4] Darlington, C. D., "The Facts of Life" (Allen and Unwin, London, 1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 24

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. T. Davis and Prof. H. Dingle: "The Age of the Universe".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Captain F. J. Wylie, R.N.(Retd.): "Radio Aids to Marine Navigation".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. William Prager (Brown University, U.S.A.): "Approximate Solution of Boundary Value Problems in Mathematical Physics by the Method of the Hypercircle in Function-space". (Further Lectures on January 27 and 28.)*

Tuesday, January 25

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. P. B. Medawar, F.R.S.: "The Errors of Nature".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. J. O'Kelly: "The Employment of Unit Hydrographs to Determine the Flows of Irish Arterial Drainage Channels".

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. Z. Young, F.R.S.: "The Language of Neurology, its Advantages and Limitations".*

Wednesday, January 26

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. C.-G. Rossby (Stockholm): "Chemical Composition of Precipitation as a Function of Atmospheric Circulation Patterns".*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. D. J. Fewings and Mr. S. L. Fife: "A Survey of Tuner Designs for Multi-channel Television Reception".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. E. Mitchell Learmonth: "Soya in the Field of Nutrition".

Thursday, January 27

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. C. Eisenstein and Prof. M. H. L. Pryce, F.R.S.: "The Electronic Structure and Magnetic Properties of Uranyl-like Ions"; Mr. J. Sawkill: "An Electron Microscope and Diffraction Investigation of Nucleation in Silver Azide".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. R. Rado: "Some Recent Work on Ordered Sets".

MINERALOGICAL SOCIETY (in the apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF FUEL (joint meeting with the COKE OVEN MANAGERS' ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Paper on the "Dutch State Mines".*

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, Westminster Bridge, London, S.E.1), at 5.30 p.m.—Mr. F. H. Ludlam: "Clouds". (Meeting open to Sixth-form scholars.)*

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. T. B. D. Terroni: "Courier to Carrier in Communications" (Faraday Lecture).

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. D. F. Lawden: "Dynamic Problems of Interplanetary Flight".

Friday, January 28

BRITISH SOCIETY OF RHEOLOGY (in the Department of Physics, Queen Mary College, Mile End Road, London, E.1), at 2.15 p.m.—Symposium on "Relaxation and Flow in Glasses".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP—NORTHERN BRANCH (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 5.30 p.m.—Prof. M. Polanyi, F.R.S.: "Objectivity from Copernicus to Einstein".

ROYAL MICROSCOPICAL SOCIETY (in conjunction with the INSTITUTE OF BIOLOGY, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr. Geoffrey Bourne: "The Living Cell".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the School of Pharmacy, Bloomsbury Square, London, W.C.1), at 7 p.m.—Annual General Meeting of the Microchemistry Group. 7.30 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. H. Munro Fox, F.R.S.: "The Colours of Animals".

Saturday, January 29

INSTITUTION OF CHEMICAL ENGINEERS, NORTH WESTERN BRANCH (at the Engineers' Club, Manchester), at 2.30 p.m.—Annual General Meeting. 3 p.m.—Sir Christopher Hinton: "Some Aspects of the Chemical Processes Ancillary to Atomic Energy".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B), to organize and teach geology and geography to the standard of General B.Sc. (London)—The Clerk to the Governors, Luton and South Bedfordshire College of Further Education, 63–69 Guildford Street, Luton (January 29).

ASSISTANT LIBRARIAN (with at least A.L.A.)—The Librarian, Chemical Society, Burlington House, Piccadilly, London, W.1 (January 29).

DEMONSTRATOR IN PHYSIOLOGY—The Secretary, London Hospital Medical College, Turner Street, London, E.1 (January 29).

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (January 31).

LECTURER (preferably with special qualifications in inorganic and analytical chemistry) IN CHEMISTRY, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, January 31).

LECTURER (with a good honours degree and some relevant experience, preferably including some research experience in the field of structures or soil mechanics) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Bristol 8 (January 31).

SENIOR EXPERIMENTAL OFFICER (with a degree or equivalent qualification and laboratory administrative experience) IN THE BIOCHEMISTRY DEPARTMENT—The Secretary, Institute of Animal Physiology, Babraham, Cambs (January 31).

HENRY AND CHARLOTTE PAYNE RESEARCH FELLOW IN CYTOLOGY and/or CYTO-CHEMISTRY, with special reference to malignant cells—The Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W.1 (February 1).

LECTURER OR SENIOR LECTURER IN BIOLOGY—The Principal, The Training College, Ripon, Yorks (February 1).

SCIENTIFIC TECHNICAL OFFICER (preferably with H.N.C. or similar qualifications in physics or chemistry), to assist in the preparation of intelligence reports, and to be responsible for internal scientific records, including preparation of monthly review of technical press—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/908 (February 2).

ANALYTICAL CHEMIST (with a degree in chemistry or at least H.N.C. in chemistry) to work mainly on the analysis of plant material—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (February 5).

DIRECTOR (with wide research and administrative experience, and ability to co-ordinate research in the various divisions of the Institute; particularly applied research) OF THE CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, Council of Scientific and Industrial Research (India), Karaikudi, South India—High Commission of India, Establishment Department, Aldwych, London, W.C.2, quoting 4/85K (February 8).

LECTURER IN APPLIED PHARMACOLOGY AND THERAPEUTICS—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (February 8).

PROFESSOR OF PHYSICS—The Registrar, The University, University Office, 46 North Bailey, Durham (February 12).

PHYSICIST (with a good honours degree in physics or similar professional qualifications, proved research ability and preferably some experience of stress analysis) in the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to lead a group carrying out research on coal ploughing—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/906 (February 16).

UNIVERSITY DEMONSTRATOR IN PHYSICS—Dr. F. B. Kipping, Chemical Laboratory, Pembroke Street, Cambridge (February 19).

ASSISTANT LECTURER OR DEMONSTRATOR IN PATHOLOGY—The Registrar, The University, Manchester 13 (February 26).

LECTURER/SENIOR LECTURER (preferably with interests and experience in clinical psychology) IN PSYCHOLOGY, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 26).

SENIOR LECTURER IN EDUCATION at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 26).

SENIOR LECTURER (with special qualifications in chemical pathology) IN CHEMICAL PATHOLOGY—The Registrar, The University, Manchester (February 26).

CHAIR OF MATHEMATICS, CHAIR OF PHILOSOPHY AND PSYCHOLOGY, and a LECTURER IN MATHEMATICS, at Canberra University College, Canberra, A.C.T., Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Canberra, February 28).

CHAIR OF PHYSICS—The Registrar, The University, Hull (February 28).

CHAIR OF ANATOMY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 1).

I.C.I. RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY, or any related subject; and LEVERHULME POSTGRADUATE FELLOWS (2) IN THE FACULTY OF SCIENCE—The Registrar, The University, Liverpool (March 1).

HEAD OF THE DEPARTMENT OF ENTOMOLOGY—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 31).

I.C.I. Research Fellows in Bacteriology, Biochemistry, Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology or Textile Industries (Protein Chemistry and Wool Textile Engineering)—The Registrar, The University, Leeds 2 (April 15).

Lecturer (with an honours degree in botany or agricultural botany, and preferably with postgraduate experience in plant physiology, ecology, genetics or virus pathology) in the Department of Agricultural Botany—The Registrar, The University, Reading (April 15).

I.C.I. Research Fellows in Physics, Chemistry, Biochemistry, Engineering, Metallurgy, Pharmacology, Chemotherapy or related subjects—The Secretary General of the Faculties, The Old Schools, Cambridge (April 30).

Agronomist, Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree, and not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical tree crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, to assist in laying down field experiments on various methods of cultivating cocoa—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/200/05.

Chemist, Senior Scientific Assistant (with a good honours degree or equivalent qualification, experience in industry, and ability to prepare correspondence and reports), at the Central Laboratory, Chiswick, to be responsible for a section concerned with a wide variety of analytical and investigational work—The Staff Officer (F/EV.507), London Transport, 55 Broadway, London, S.W.1.

Experimental Officers (preferably with a pass degree), and Assistant Experimental Officers (with at least H.S.C. (science) or equivalent), to assist in the preparation of experimental equipment and in the carrying out of nuclear physics experiments—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 349/WGE/34.

Experimental Officer (with a degree or equivalent qualifications) in the Nutrition Department, to assist in biochemical research involving chromatography and electrophoresis—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/2.

Forestal Land, Timber and Railways Co., Ltd., Research Fellow (with at least a good honours degree in chemistry, and preferably some research experience, and particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance), at the Central Research Laboratory of the Department of Scientific and Industrial Research, Teddington, for research which will be directed to investigating the function of tannins in preventing corrosion of metals—Chief Research Chemist, Forestal Central Laboratory, Harpenden, Herts.

Head of the Department of Chemistry and Biology; and Head of the Department of Engineering, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

Lecturers (2) (with an engineering or science degree, lecturing experience, and a specialist knowledge of either electrical engineering or electronics, or survey mechanism) at the R.E.M.E. Training Centre, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.679/54A.

Master to teach Mathematics up to University Scholarship standard—The Headmaster, Highgate School, London, N.6.

Mathematicians and Theoretical Physicists, to investigate a range of problems in classical and nuclear physics—The Deputy Director, Atomic Weapons Research Establishment, Aldermaston, Berkshire.

Nuclear Physicists, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree in physics or equivalent qualification, and in the case of the S.S.O. posts some years postgraduate research experience in nuclear physics), to work with a 6 MeV. Van de Graaff generator and other accelerators—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 348/WGE/34.

Principal (with experience of teaching, administrative ability and a knowledge of agricultural practice) of the Institute of Agriculture and Horticulture, "Oaklands", St. Albans—County Education Officer, County Hall, Hertford.

Senior Research Assistant (with a good honours degree in engineering, practical experience and/or research training) in the Department of Civil and Mechanical Engineering—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Psychology as the Study of Behaviour: an Inaugural Lecture. By Prof. O. L. Zangwill. Pp. 36. (London: Cambridge University Press, 1954.) 2*s.* 6*d.* net. [1911

The Fruit, The Seed and The Soil. Prepared by the Staff of the John Innes Institution. (Collected edition of the John Innes Leaflets Numbers 1 to 9.) Third edition. Pp. viii+94 (6 plates). (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 5*s.* net. [1911

Group Discussion in Educational, Social and Working Life. Edited by John Burton. Pp. 92. (London: Central Council for Health Education, 1954.) 3*s.* 6*d.* [1911

Imperial College of Science and Technology. (University of London.) Research Report of the Royal School of Mines, 1950–53. Pp. iv+33. (London: Imperial College of Science and Technology, 1954.) [1911

Department of Scientific and Industrial Research. National Physical Laboratory. Notes on Applied Science No. 8: Audio Frequency Power Measurements. Pp. iv+16. (London: H.M. Stationery Office, 1954.) 1*s.* net. [1911

Aluminium Development Association. Information Bulletin No. 8: The Riveting of Aluminium. Pp. 62. (London: Aluminium Development Association, 1954.) 2*s.* [1911

Institution of Gas Engineers. Publication No. 455: Chemical Research at the Direction des Études et Recherches du Gaz de France. By P. C. Agron. Pp. 28. Publication No. 456: The West Midlands Approach to the Gasification of Residual Oil. By G. le B. Diamond. Pp. 40. Publication No. 457: The Production of Town Gas by the Catalytic Gasification of Petroleum Oils. 2: The Development and Operation of a Commercial Plant. By H. Stainer and J. B. McKeag. Pp. 30. Publication No. 459: Official Programme—20th Autumn Research Meeting, London, 22nd and 23rd November, 1954. Research Communication GC14: Investigations with a Small Pressure Gasifier. Part 1: The Study of the Reactions Occurring in the Fuel Bed. By Dr. D. Hebden, R. F. Edge and K. W. Foley. Pp. 32. Research Communication GC17: An Investigation into the Composition of Ammoniacal Liquor. 1: Continuous Vertical Retort Liquor. By Dr. W. H. Blackburn Dr. L. Barker and J. R. Catchpole. Pp. 48. Research Communication GC18: A Review of Current Research Work on the Treatment and Disposal of Liquor Effluents from Gas Works. By Dr. A. L. Roberts and Dr. W. B. Blackburn. Pp. 14. Research Communication GC19: Coal Travel in Continuous Vertical Retorts. By C. H. Lewis. Pp. 25. (London: Institution of Gas Engineers, 1954.) [1911

Proceedings of the Croydon Natural History and Scientific Society. Vol. 12—February, 1951 to December, 1952. Pp. 81–154 + plates 7–18. 10*s.* The Excavation of a Fourth Cave at Waddon. By A. B. L. Reid. Pp. 7. 2*s.* The Denehole Controversy. By John E. L. Calger. Pp. 12+2 plates. 2*s.* The Re-Birth of Croydon in 1851. By D. W. Blackmore. Pp. 22+10 plates. 3*s.* The Coombes and Embayments of the Chalk Escarpment. By C. C. Fagg. Pp. 15. 2*s.* (Croydon: Croydon Natural History and Scientific Society, 1954.) [1 11

Other Countries

Proceedings of the Royal Society of Arts and Sciences of Mauritius. Vol. 1, Part 3: A Forgotten Work by John Vaughan Thompson. By R. E. Vaughan. Pp. 241–248+plate 8. (Port Louis: Royal Society of Arts and Sciences of Mauritius, 1953.) [1911

British Caribbean Meteorological Service. Second Annual Report, 1953. Pp. 15. (Trinidad: British Caribbean Meteorological Service, 1954.) 24 cents. [1911

Union of South Africa. Department of Mines—Geological Survey. The Geology of the Koedoesrand Area, Northern Transvaal: an Explanation of Sheets 35 and 36 (Koedoesrand). By H. N. Visser. Pp. iii+110+14 plates. (Pretoria: Government Printer, 1953.) 10*s.* (including map). [1911

Union of South Africa. Department of Mines and Department of Economic Affairs. Coal Survey. Memoir 2: The Northern Natal Coal-Field (Area No. 2). The Utrecht-Newcastle Area. Part 1: Geological. By J. J. G. Blignaut and F. J. J. Furter. Part 2: Chemical and Physical. By W. H. D. Savage. Pp. iv+228. (Pretoria: Government Printer, 1952.) 30*s.* (including maps). [1911

New Zealand: Department of Scientific and Industrial Research. Geophysics Division—Seismological Observatory. Seismological Report for July, August, September, 1951. (Bulletin E. 125.) Pp. ii+18. (Wellington: Government Printer, 1954.) [1911

Smithsonian Miscellaneous Collections. Vol. 123, No. 3: A Method for the Measurement of Atmospheric Ozone Using the Absorption of Ozone in the Visible Spectrum. By Oliver R. Wulf and James E. Zimmerman. (Publication 4177.) Pp. ii+14. Vol. 123, No. 5: Concerning Smithsonian Pyrheliometry. By C. G. Abbot, L. B. Aldrich and A. G. Froiland. (Publication 4179.) Pp. ii+4. (Washington, D.C.: Smithsonian Institution, 1954.) [1911

Bulletin of the Scripps Institution of Oceanography of the University of California, La Jolla. Vol. 6, No. 7: Bathypelagic Nemerteans of the Pacific Ocean. By Wesley R. Coe. Pp. iii+225–286+plates 8 and 9. (Berkeley and Los Angeles: University of California Press, 1954.) 75 cents. [1911

University of California Publications in Zoology. Vol. 52, No. 5: Comparative Morphology of the Body Skeleton in Recent Canidae. By Milton Hilderbrand. Pp. iii+399–470+plates 12–25. 1 dollar. Vol. 54, No. 1: Ecology and Systematics of Salamanders of the Genus Batrachoseps. By John R. Hendrickson. Pp. iii+46. 75 cents. (Berkeley and Los Angeles: University of California Press, 1954.) [1911

United States Department of Commerce. Weather Bureau Research Paper No. 37: Pressure Jump Lines in Midwestern United States, January–August 1951. By Morris Tepper and other Staff Members of Severe Local Storms Research Unit. Pp. v+70. (Washington, D.C.: Government Printing Office, 1954.) 45 cents. [1911

United States Department of Agriculture. Leaflet No. 372: The Onion Thrips: How to Control It. Pp. 4. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [1911

East African Meteorological Department. Technical Memorandum No. 6: Artificial Inducement or Precipitation in the Tropics. By D. A. Davies. Pp. 11. (Nairobi: East African High Commission, 1954.) Sh. 1/50. [1911

Tea Research Institute of East Africa. Annual Report for the year 1953. Pp. 43. (Kericho: Tea Research Institute of East Africa, 1954.) [1911

Fisheries Research Board of Canada. Progress Reports of the Atlantic Coast Stations. No. 59. Pp. 31. (St. Andrews, N.B.: Fisheries Research Board of Canada, 1954.) [1911

Cawthron Institute. Annual Report, 1953–54. Pp. 42+3 plates. (Nelson, N.Z.: Cawthron Institute, 1954.) [1911

Role of Science in the Development of New Zealand Agriculture. By Sir Theodore Rigg. (Presidential Address to the Australian and New Zealand Association for the Advancement of Science, Canberra, January 13th 1954.) Pp. 35. (Canberra: Australian and New Zealand Association for the Advancement of Science, 1954.) [1911